# AN EXAMINATION OF BATTALION TRAINING AT THE NATIONAL TRAINING CENTER

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# NAVAL POSTGRADUATE SCHOOL
## Monterey, California


# THESIS

AN EXAMINATION OF BATTALION TRAINING
AT THE NATIONAL TRAINING CENTER

by


Timothy James Reischl


March 1980

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# An Examination of Battalion Training at the National Training Center

by

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Submitted in partial fulfillment of the requirements for the degree of

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from the

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March 1980

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## LIST OF ABBREVIATIONS

| | | |
|---|---|---|
| AA | - | Anti-aircraft |
| AAR | - | After action review |
| A/C | - | Aircraft |
| ADA | - | Air defense artillery |
| APC | - | Armored personnel carrier |
| AR/AAV | - | Armored reconnaissance/airborne assault vehicle (M-551 Sheridan) |
| ARTEP | - | Army Training and Evaluation Program |
| ARTS | - | Army Training Study |
| AT | - | Anti-tank |
| ATGM | - | Anti-tank guided missile |
| BLUEFOR | - | Blue forces (friendly unit) |
| CACDA | - | Combined Arms Combat Developments Agency |
| CAS | - | Close air support |
| CATTS | - | Combined Arms Tactical Training Simulator |
| CDEC | - | Combat Developments Experimentation Command |
| COMSEC | - | Communications security |
| CP | - | Command post |
| CPX | - | Command post exercise |
| CS | - | Combat support |
| CSR | - | Controlled supply rate |
| CSS | - | Combat service support |
| DF | - | Direction finding |
| DMA | - | Defense Mapping Agency |
| EEFI | - | Essential elements of friendly information |

ELINT - Electronic intelligence

EMC - Exercise Maneuver and Control

ES - Engagement simulation

FA - Field Artillery

FAC - Forward air controller

FADAC - Field artillery digital automatic computer

FDC - Fire direction center

FFAR - Folding fin aerial rocket

FIST - Fire support team

FO - Forward observer

FORSCOM - Forces Command

GSR - Ground surveillance radar

HAW - Heavy Anti-tank Weapon (TOW)

ID - Identity/identify

IF - Indirect fire

IFV - Infantry fighting vehicle

IOC - Initial operating capability

IPO - Input, Process, Outcome

LAW - Light Anti-Tank Weapon

LFS - Live Fire System

LOS - Line of sight

MAW - Medium Anti-tank Weapon (Dragon)

MG - Machinegun

MIJI - Meaconing, Intrusion, Jamming, Interference

MILES - Multiple Integrated Laser Engagement System

MOE - Measure of effectiveness

MOP - Measure of performance

| | | |
|---|---|---|
| MWS | - | Major weapons system (tank gun, TOW, Sagger) |
| MRB | - | Motorized rifle battalion |
| MRR | - | Motorized rifle regiment |
| NBC | - | Nuclear, biological, chemical |
| NTC | - | National Training Center |
| OPFOR | - | Opposing force |
| OP/LP | - | Observation post/Listening post |
| PL | - | Position location |
| PL/ERS | - | Position Location/Event Recording System |
| POMCUS | - | Positioning of materials configured to unit sets |
| REALTRAIN | - | Realistic training |
| R-T | - | Receiver-transmitter |
| SIGSEC | - | Signal security |
| TAF | - | Training Analysis and Feedback |
| TCATA | - | TRADOC Combined Arms Test Activity |
| TCU | - | Target Control Unit |
| TETAM | - | Tactical Effectiveness Testing of Anti-tank Missiles |
| TF | - | Task force |
| TOE | - | Table of Organization and Equipment |
| TOW | - | Tube launched, optically tracked, wire guided missile |
| TRADOC | - | Training and Doctrine Comand |
| TSM | - | TRADOC Systems Manager |
| VTR | - | Vehicle, Tracked Retriever |
| WP | - | White phosphorous |
| WSI | - | Weapons system interface |

# I. INTRODUCTION

The fast pace of modern mechanized warfare and the impact of increasingly complex and lethal weapons systems have placed growing demands on the U.S. Army training system to continue to provide well trained individuals, crews, and combat units to meet the challenging demands of the modern battlefield. Because of increased training complexity, Army units have been limited in the amount and quality of training that can be given to its basic combat elements - the company/team and the combined arms battalion task force [5]. The increasing emphasis placed on the employment of these unit echelons in combat has mandated a requirement for an effective training program. In general, unit training at home station is limited by:

- lack of an appropriately sized training area
- restrictions on employment of realistic close air support, electronic warfare, supporting artillery, and live fire because of local regulations
- lack of realistically equipped aggressor forces in proper unit strength
- insufficient training funds to acquire and maintain sophisticated training aids and training ammunition
- local distractors (post detail, personnel turnover, ancillary training, exercises, etc.) which tend to limit the amount of training time and personnel available for unit training.

The Army's training problems were thoroughly probed by the Army Training Study Group (ARTS) in 1977-78 [22]. Their conclusions highlighted the factors previously mentioned

and suggested remedies to improve collective training. Recommendations applicable to this paper included:

a need to rapidly apply new training technology to training problems

to attack the unit training problem by focusing on training the leaders within the unit

a need for independent verification of unit proficiency.

The findings of the ARTS Group were largely anticipated in early 1977 when the National Training Center (NTC) concept was first articulated at Headquarters, Training and Doctrine Command (TRADOC) and approved by the Vice Chief of Staff of the Army [19]. The National Training Center concept was proposed as an aid in solving the training problem through creation of large training areas in separate geographic regions where intense, highly supported training could be undertaken by combined arms battalions. This training would take the form of instrumented force-on-force maneuvers and realistic live-fire exercises over a two-week training period. In addition to the maneuver units, battalion staffs would come to NTC to take part in wargaming and command post exercises (CPX) which would polish control procedures without the expense of moving an entire battalion.

The NTC concept has since been compressed to a single area, Fort Irwin, California, where mechanized task forces (tank and mechanized infantry battalions), their attendant brigade headquarters and supporting elements, and battalion staffs will be trained. The stated purpose of the National Training Center is:

> ....to establish a place where Army units can undertake essential combined arms training that cannot be accomplished at home station due to physical limitations and/or prohibitive total cost of providing an NTC type environment at all home stations; and to gather hard data about battlefield performance and effectiveness of organizations and systems under realistic simulated conditions.[1]

The key objective of the NTC is therefore to raise Army readiness by providing realistic training and objective training feedback to the battalions training at Fort Irwin using a TRAIN-EVALUATION-TRAIN methodology.

This approach to improving Army readiness through realistic training and objective feedback at the battalion level has its roots in Army lower echelon training and is related to similar training received by Air Force and Navy flight crews. In the 1974-1976 timeframe the Army developed its REALTRAIN (Realistic Training) concept for use by squads and platoons [7,20,21]. The REALTRAIN concept used relatively crude optical devices and close monitoring by controller personnel in force-on-force mock battles between infantry and tank platoons. The real time casualty assessment and immediate training feedback provided was found to increase unit proficiency sharply, especially when repeated exercises were used. REALTRAIN's chief drawbacks were the large numbers of controller personnel needed and its limited evaluation

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[1] National Training Center Development Plan, 3 April 1979, p. I-2.

apability. Navy flight crews began using similar training echniques in 1969 and were able to raise their air-to-air ill ratio in Southeast Asia from 2:5 to 1 in 1965-68 to 2:1 from 1970-73. Following the Navy's example the Air orce has installed a large instrumented combat training ange, code named Operation RED FLAG, in the desert near ellis Air Force Base, Nevada. There, flight crews are trained gainst opposing forces (OPFOR) employing Soviet-style tacics and equipment and engage in realistic simulated missions - ll in a closely monitored environment which detects and ecords every move for later analysis. Post-mission deriefings and remedial training are used to ensure that the rews have learned essential combat skills [24].

The Army's National Training Center thus draws from a roven training concept. However, the NTC concept statement ocuses on the combined arms battalion and requires objective valuation at that level, and these requirements add significantly o the scope of the problem. The RED FLAG and REALTRAIN raining concepts focus on a few aircraft or an infantry latoon. The NTC must track and evaluate a combat battalion ith 50-70 combat vehicles and 800 men, as well as supporting rtillery, engineers, and close air support. A force-onorce training exercise against a realistically sized threat orce requires the instrumentation of up to 450 players vehicles and weapons systems) on a battlefield up to 20 x 40 M. Live-fire exercises require similar instrumentation,

but employ an automated target system. The training concept for the battalion task force thus creates a difficult data collection and reduction problem. The requirement for objective evaluation of the battalion poses a two-fold problem - the determination of evaluation measures and the amount and type of data which is to be collected. Army training evaluations, notably the ARTEP (Army Training Evaluation Program) have generally been very subjective in nature, due to a lack of suitable instrumentation. Proven objective evaluation measures do not exist for a battalion, though development work in this area has been done. A preliminary CATRADA study [18] lists hundreds of measures of effectiveness (MOE) and measures of performance (MOP) applicable to a battalion task force. The large numbers of performance measures cause one to focus on the second part of the evaluation problem, the need to determine how much data is required to evaluate a battalion. Given the data collection constraints and a need to quickly reduce performance data for training feedback there is clearly a limit on how much data can be collected and used. The problem is to identify these performance measures and collection levels which are most important in the evaluation of battalion performance.

In discussing the background and purpose for the National Training Center it can be seen that the Army has begun an ambitious and complex program to increase the readiness of its combat battalions through the use of realistic training and objective evaluation. This paper has a twofold goal in

dealing with the National Training Center concept. The accomplishment of these two goals will provide a basic understanding of the complex issues at NTC and serve to underscore areas in which additional work must be done. The first goal is to examine the operating format, the instrumentation system, and the evaluation concept which will make the NTC the most sophisticated training area in the Army training system. This examination focuses on the field training of maneuver battalions at NTC and the assumptions and problems which affect operations and the evaluation process. The instrumentation system is described in the light of its capabilities and the data which it can supply for the evaluation process. The second goal is an analysis of the current evaluation methodology and the contributions of the instrumentation in the measurement of unit performance. Focusing on data collected by instrumentation, the analysis looks first at ways to increase the amount of data collected by instrumentation. Then, a different technique is proposed for structuring the unit performance measures in an effort to determine their contribution to the analysis of unit performance.

The rapidly evolving nature of the National Training Center requires that a caveat be included in this paper. At the time this paper was written the NTC was undergoing rapid changes in both its operation and its structure. The list of references cites numerous drafts and working papers which

constitute the only specific information known about many areas of NTC. The information contained in them is accurate as of 10 February 1980. Located at Appendix A is a research chronology which lists dates and agencies which were used in the preparation of this paper. It must be anticipated that future changes in NTC operating policy will alter some of the facts and conclusions in this paper.

## II. OPERATING CONCEPTS

An expanded description of the form and functions of the NTC is provided by the TRADOC System Description:

> ....The National Training Center will consist of an instrumented live fire range, a maneuver area capable of accommodating opposing armor or mechanized infantry battalions, a centralized exercise control and training analysis facility, and field instrumentation to provide location and status/event data for ground and air systems, to simulate weapons systems engagements and to assess in real-time simulated casualties and damage. It will also include range communications, electromagnetic spectrum management, field controllers, a voice and video recording system, and necessary administrative/logistic support. The National Training Center will replicate as faithfully as possible the battle conditions expected in NATO versus Warsaw Pact conflict to include opposing forces' weapons, tactics, uniforms, and other equipment; electronic warfare; and battlefield obscuration. It will emphasize timely on the spot critique and formulation of a "take home" remedial training package. Finally, exercise and live fire outcomes will be used to assess doctrine; tactics, organization, and weapons system performance.[2]

While this statement describes more fully the activities which will occur at NTC it falls short of supplying the necessary operating parameters within which unit evaluations must be conducted. A detailed examination of proposed operating concepts is a requirement in order to specify a method of evaluation and identify the factors which affect it.

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[2] National Training Center Phase I Instrumentation System, Statement of Work, Revision 1, p. 4, 26 November 1979.

A. IMPLEMENTING AND OPERATING SCHEDULES

1. NTC Implementation Schedule

The implementation of the National Training Center occurs in two phases, the first scheduled for July 1981 [23]. The phases are keyed to the amount and sophistication of the instrumentation employed at NTC. Phase I calls for simpler off-the-shelf instrumentation hardware, designed to get the NTC operating at the earliest possible date. Phase II, planned for FY 85, will feature more sophisticated hardware, designed specifically with NTC in mind and capitalizing on the experience gained in Phase I. Phase II instrumentation will be more accurate and capable of measuring increased numbers of unit parameters. Prior to Phase I several concept tests will be conducted to evaluate both instrumentation and NTC operating concepts. The Phase I initial operating capability (IOC) in July 1981 calls for a capability of NTC to train 20 combined arms battalions a year. The battalions will come to NTC for two weeks, controlled by their parent brigade headquarters. The number of battalions trained annually will gradually be increased until full capacity is reached in FY84. At full capacity 42 battalions will train at NTC each year, a new pair arriving every two weeks. At full capacity effective scheduling and adherence to mission timetables will be critical in order to maximize both the training benefit to the unit and the utilization of the instrumented training area.

2. Unit Training Schedules

A sample training schedule [23] for a battalion task force is displayed at Appendix B. The six mission periods designated in the tactical training period are designed to move the unit through different mission scenarios and increase unit proficiency. The training periods are of 36-48 hours duration and may be used in a single block for a multiple mission scenario or broken into smaller blocks for repetitive training at a specific mission, depending on the needs of the training unit. The evaluation scheme must be flexible enough to deal with either option and the instrumentation must have sufficient operating capacity for at least 48 hours of continuous use. The mission critiques must be structured so as to fit into the 12-hour break period and yet allow for unit maintenance and preparation for the next mission.

## B. TRAINING REALISM

Field testing and experience with the ARTEP since 1975 have indicated a direct relationship between the realism of the training environment and unit proficiency [19,20,22]. Figure 1,[3] illustrates the relationship between unit proficiency and training realism. Improvements in the realism of the training environment have been shown to contribute to increases in unit proficiency, especially when coupled with immediate training feedback [21]. The NTC seeks to exploit this

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[3] National Training Center Development Plan, p. II-2, 3 April 1979.

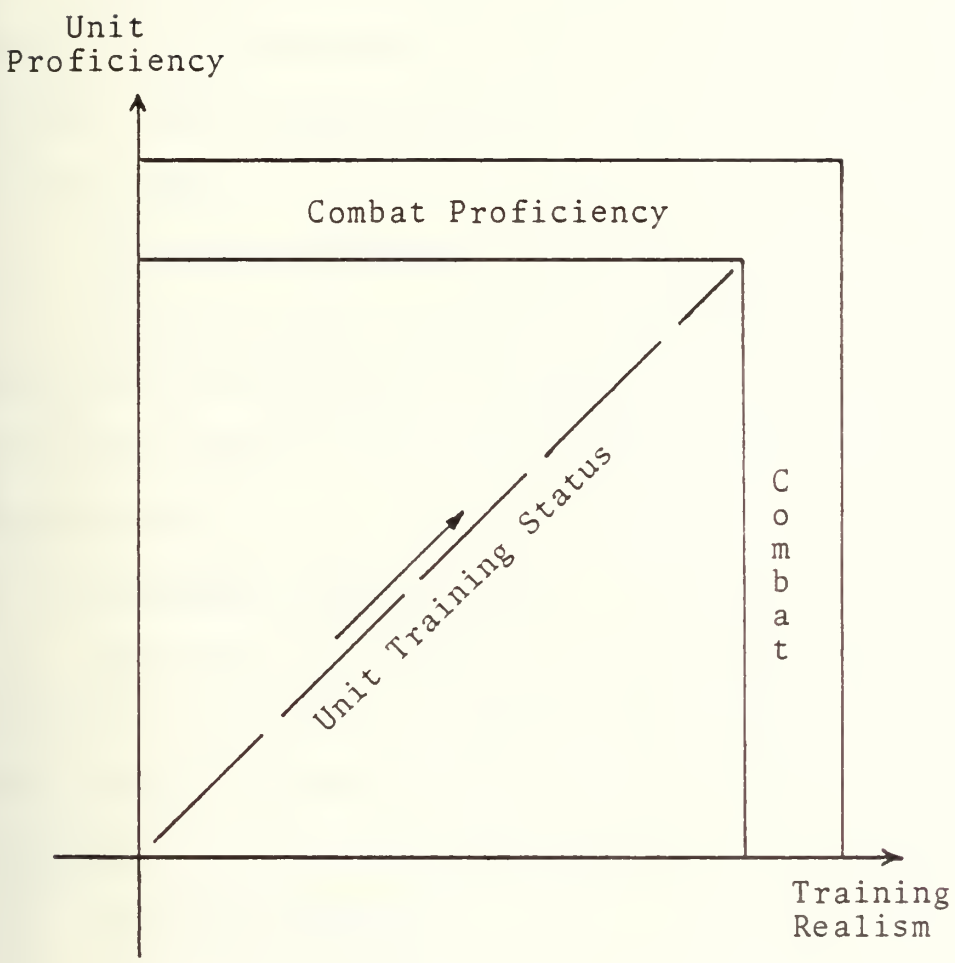


figure 1.

Unit Proficiency As Related To
Exercise Realism

interrelationship by providing for the training unit a realistic battlefield which is as close to the combat environment as possible. The essential elements [23] in this environment are:

1. <u>Opposing Forces (OPFOR)</u>

Realistic opposing forces will be provided to support training. A Soviet-style motorized rifle regiment with full equipment (230 tracked vehicles, 1000 men) will be stationed at Fort Irwin.

2. <u>Electronic Warfare</u>

Because of the isolated nature of Fort Irwin full power jammers operating at realistic locations may be used to duplicate OPFOR electronic warfare practices in all frequency spectra.

3. <u>Close Air Support (CAS)</u>

The NTC will allow employment of close air support both in the engagement simulation and live fire modes. Joint planning necessary for air-ground operations can be accomplished by the agencies responsible for CAS execution.

4. <u>Dirty Battlefield</u>

Battlefield obscuration, NBC, engineer counter-mobility exercises, and other operations which tend to create confusion on the battlefield will be available at NTC. Normal battlefield irritants such as dust, smoke, and fire will also be simulated at NTC.

5. <u>Live Fire</u>

A large live-fire maneuver and impact area will allow realistic weapons delivery (within safety margins) and

simultaneous employment of direct and indirect fires. A dynamic target system will represent the opposing force and will be provided with instrumentation for after action analysis.

6. Engagement Simulation

MILES (Multiple Integrated Laser Engagement Systems) will be used on OPFOR and friendly elements to provide real-time casualty assessment in force-on-force-exercises.

7. Instrumentation

Position location systems, event recorders, voice and video recorders coupled to an analysis facility will enhance the ability of evaluation personnel to make accurate, objective assessments of unit performance. Field controller evaluation by qualified personnel will also be used to assess unit performance.

8. Deployment Simulation

Training battalions will be airlifted to Fort Irwin. They will be required to draw and use POMCUS (Positioning of Materials Configured to Unit Sets) equipment, using procedures similar to those required for an actual deployment in Europe.

## C. EVALUATION PHILOSOPHY

1. General

Units at the NTC will use the TRAIN-EVALUATE-TRAIN model during operations at Fort Irwin [23]. Evaluations will be based on objective measures of performance which are

closely tied to hard data collected by instrumentation. Initial After Action Reviews (AAR) will be presented to key unit leaders not more than two hours after the conclusion of a training exercise. These AARs will critique unit performance, highlight key events, and present evaluation results through the use of interactive computer graphics, voice and video recordings, and a synthesis of the other data inputs. A final AAR will be conducted at the end of a unit's two week training period and will focus on overall unit strengths and weaknesses, again supported by objective data. A "take-home" package of training results will be furnished to the unit so that home station training may be directed at resolving weaknesses identified at NTC.

Effective evaluation is an important training tool, but it must not limit unit training. The evaluation process must be as transparent to the user as possible, and must not impose burdens on the unit which will reduce training realism or unit effectiveness. The complex instrumentation system, as described in Chapter III, will not be allowed to drive training, but will be responsive to the needs of the unit being trained. Operational problems with the instrumentation system will not dictate cancellation of an exercise but will force a manual, more subjective evaluation of unit performance by the evaluation team. The tight schedule of units at NTC will not allow otherwise.

2. The Role of Evaluation at NTC

An issue which is essential to the design of an evaluation system for NTC deals with the role of unit training and evaluation and the reasons for assessing unit effectiveness at NTC.[4]

Various reasons for assessing unit performance have been articulared, and these views can be pictur-d as lying on a scale with two distinct end points. At one end lie those which point to NTC as a test of unit performance, with evaluation geared in that direction. The evaluation scheme of the "test" community would be directed more to hard performance data and measurement of performance against a standard to determine a performance level. At the opposite end of the continuum is the view that the training and evaluation at NTC is only a resource which provides the unit with the capability to diagnose its weaknesses and apply remedial action. The "diagnostic" community sees evaluation more as a descriptive process and uses standards only as yardsticks of performance level, not absolute goals to be attained. These two views, as well as those in between, share a common bond in that their performance measures are drawn from the same core of unit data. Information from this core can be drawn and packaged in different ways to satisfy varying the evaluation

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[4]The ideas expressed in this paragraph were developed in a conversation with Dr. Duncan Hansen of Science Applications, Inc.

purpose. A decision, made essentially by the Army command structure, must place the NTC evaluation policy somewhere along the evaluation continuum.

3. <u>The NTC As Part Of Army Training</u>

In recent years the Army has attempted to order and systematize its training efforts in an attempt to raise the proficiency of all levels of the Army and provide emphasis in those areas deemed most important to the success of Army missions. This effort, though far from complete, has resulted in the implementation of the Skill Qualification Test (SQT) for individual soldiers and the Army Training and Evaluation Program (ARTEP) for collective training at the various unit echelons from squad to battalion. Because of its unique training opportunities (and also potential drawbacks) the NTC concept must be integrated into Army training so that it can complement existing training systems and expand the training opportunity into areas where gaps now exist.

The NTC, with its large maneuver space, capacity for realistic training, and objective evaluation system, is a capstone for training at the battalion level. It must focus on those activities of a battalion which cannot be exercised or evaluated at home station. Simply to duplicate the battalion ARTEP would be a waste of resources. The NTC will concentrate on the battalion's coordinated application of its organic and supporting fires to accomplish a desired mission. Because any evaluation system cannot measure all the activities occurring in a battalion, the NTC evaluation system must

concentrate on those fundamental operations which measure a battalion's performance. This limitation means that some training activities, primarily at the crew/squad and platoon level, will be lost or disregarded if not essential to the battalion evaluation. This lost training must be accomplished at home station. The resources at the NTC must focus on the battalion and training which can only be done at NTC.

It is important also to put the NTC in perspective regarding its effect on the unit training schedules at home station. Unit training must be geared to send well prepared units to NTC. However, the NTC mission, or fear of unit failure at NTC, must not be allowed to drive the allocation of all training time and resources at a unit's home station. In recent years a drive toward multi-echelon unit training has helped eliminate the "peak and valley" effect in unit readiness. As a result, units now spread their training throughout the training year instead of having brief concentrated training periods which bring high unit readiness, only to have combat proficiency slip during long gaps between training cycles [2].

Even at peak operating capacity at NTC, units will only train at Fort Irwin once every 18 months. Unit commanders will thus normally exercise at NTC only once during their command tours. To overemphasize individual unit preparation before NTC could actually weaken overall Army readiness unless the training cycle and NTC are viewed in proper perspective.

## D. TACTICAL MISSIONS AT NTC

The purpose of the National Training Center is to support the training of tank and mechanized infantry units in typical NATO-Warsaw Pact scenarios. Because of the limitations imposed by the terrain at Fort Irwin, the portability and operational characteristics of the instrumentation, and the configuration of the POMCUS equipment, training will be limited to tank and mechanized infantry battalions and armored cavalry squadrons and their supporting units. The capability to instrument dismounted infantry battalions is not present at NTC.

Appendix C lists the tactical missions which will be available for training units at the NTC [23]. These missions will be practiced by units either in a live fire or instrumented force-on-force scenario. Particular missions, mission sequence, and scenarios will be determined by training units in conjunction with NTC cadre 30-90 days before deployment to Fort Irwin. Missions may be practiced singly or grouped in random order, depending on unit desires and time availability. The commonality of evaluation measures for particular unit types across the mission spectrum is a potential problem. This issue is more fully developed in the evaluation section of this paper.

## E. NTC LOCATION

In July 1979 Fort Irwin, California was selected from a group of candidates as the site for the National Training

Center. A deactivated Army post now used by the California Army National Guard, Fort Irwin will revert to Army control in January 1981 [23]. Because of its location, terrain characteristics and desert environment Fort Irwin offers advantages as well as challenges to training units and to the successful implementation of the National Training Center. These factors directly influence the type of training which can be conducted, its frequency, and the evaluation used to critique training.

1. Location

Fort Irwin is located in the high desert of central California and covers an area of approximately 642,000 acres. The nearest civilian community is Barstow (population: 18,000), located 38 miles to the south and connected to Fort Irwin by a two lane highway. Fort Irwin contains the normal facilities found on a post of comparable size: post exchange, commissary, hospital, fire station, military police, etc. It contains troop barracks and 288 sets of officer and enlisted housing, not enough to house all of the permanent cadre personnel to be assigned to operate the NTC [24]. Significant numbers of cadre personnel and civilian technicians will make the 75-mile round trip to Barstow daily. Training units will be quartered tactically in the field and pose no burden on post housing. A dirt air strip (Bicycle Lake Army Air Field) exists on post, but it will not handle troop carrier aircraft. Training units will deploy into George AFB, located 65 miles to the southeast and be transported to Fort Irwin. Motor pool and

maintenance facilities exist, but they have not previously operated at the level required by the NTC. The nearest railhead is in Barstow, therefore all shipments to Fort Irwin must be made by road until FY 1984 when a spur is scheduled to connect with the railhead in Barstow.

The isolation of Fort Irwin provides a benefit in that a wide spectrum of training activities can be undertaken without interfering with the local civilian population. EW operations, low flying aircraft, the use of CS and smoke can be used with few restrictions. However, the remote location of the NTC will almost certainly affect maintenance of vehicles and equipment and will require key personnel to be quartered on or near Fort Irwin. Shift schedules for evaluation and operations personnel will be influenced by quarters location as well as training requirements. Personnel problems associated with long term duty at an isolated post can be anticipated.

2. Terrain

The terrain at Fort Irwin is properly described as high desert (mean elevation is 2300 feet) and is an interesting combination of mountain ranges, broad valleys, and isolated hill masses [24]. Soil composition is sand and volcanic rock which offers good trafficability in all seasons. Even the smooth terrain is quite broken with rills and small gullies which impede vehicle movement but offer limited cover and concealment for individual soldiers and vehicles. Scrub vegetation is relatively plentiful, offering some concealment,

but it is not dense enough to provide concealment from the air. Maneuver is limited only by terrain features and numerous artillery impact areas, which will be cleared prior to IOC for the NTC. Fort Irwin lacks a good road net within the major parts of its maneuver area, limiting access primarily to tracked and four-wheel drive vehicles. This limitation, as well as the rough nature of the terrain, will stress the reliability of on-vehicle instrumentation equipment and limit movement around the maneuver area by controllers and maintenance crews unless properly mounted.

Figure 2 shows the two primary training areas to be used at Fort Irwin.[5] Each of these areas will be fully instrumented for evaluation, including the buffer areas. The requirement for a single main evaluation center near the cantonment area places a burden both on the instrumentation and the evaluation team. Large amounts of performance data must be efficiently transmitted over large distances (up to 40 km) to the evaluation center for analysis. The requirement for immediate critique for large numbers of personnel requires that debrief materials (TV tapes, voice recordings, computer output) be portable so that they can be used at a field site.

Perhaps the most serious impact of the terrain at Fort Irwin is its effect on unit training and tactical operations. Fort Irwin is not typical European terrain. Its topography

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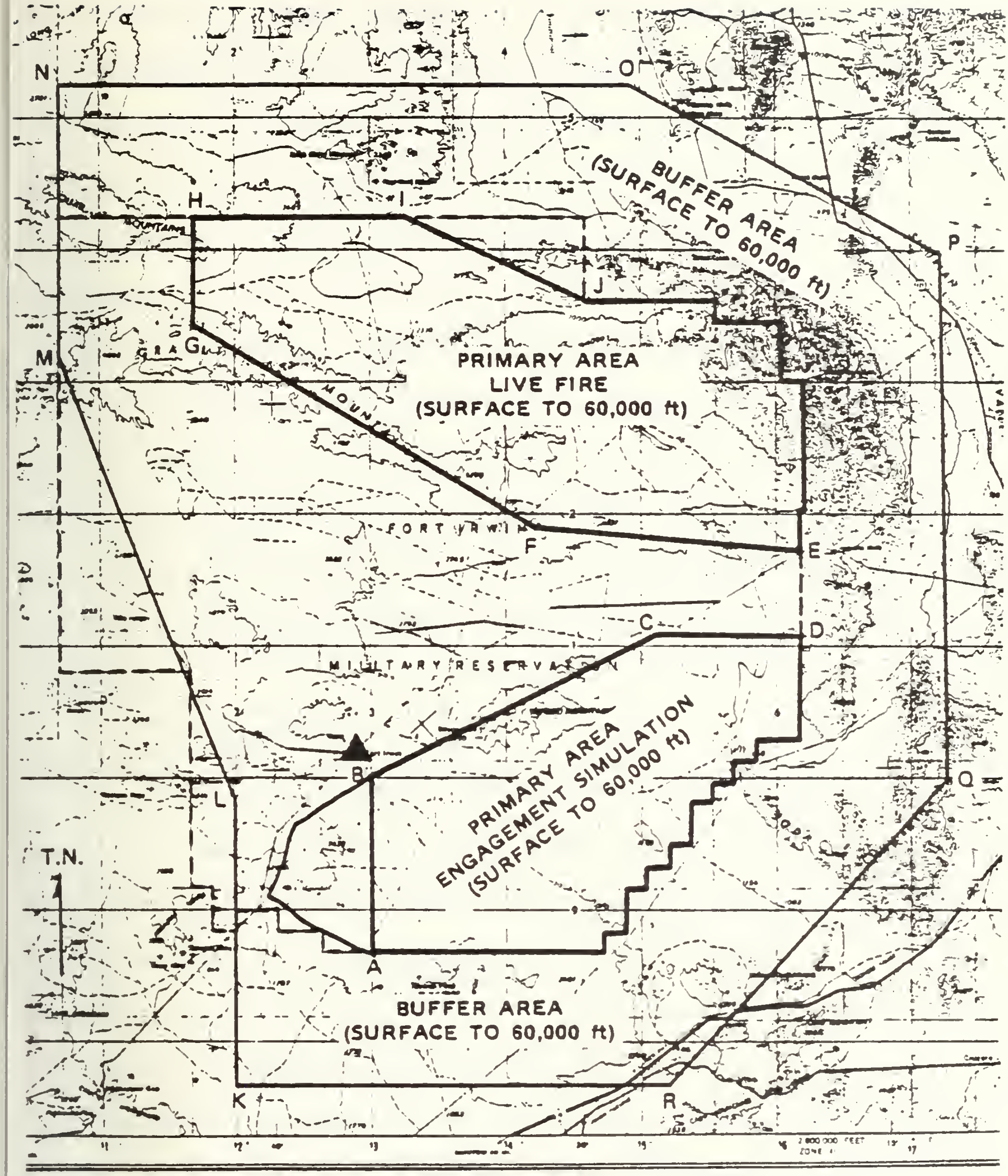
[5] Prime Item Development Specification for Position Location/Event Registration System of the U.S. Army National Training Center Field Instrumentation Package, Revision 1, p. 22, 26 Nov 1979.




▲ - Cantonment Area

figure 2.

Fort Irwin Primary Maneuver Training Areas

and inter-visibility ranges are quite similar to Europe, but the absence of the concealment offered by European vegetation, the lack of a comparable road net and urban buildup, and the desert soil conditions (providing dust signatures, etc.) must affect the way in which a unit operates. Performance measures, if they are styled to be valid in Europe, may not apply in the desert. Great care must be taken in the evaluation to critique a unit on what it does at Fort Irwin, not what it should do in Europe. The terrain tradeoff, necessary to acquire maneuver space and realistic conditions, need not limit the effectiveness of NTC. Sound tactics and good unit leadership are fundamentals which apply regardless of terrain variation.

3. Environment

The environmental conditions at Fort Irwin, like the terrain, pose significant problems to the evaluation process. High desert areas have wide daily temperature variations. Variations of up to 70 degrees are not uncommon. Adverse weather conditions are characterized principally by low temperatures and high winds. Weather extremes will affect the instrumentation used at NTC and rugged design is a requirement. A preliminary equipment test in January 1980 was delayed when 80-knot winds prevented the erection of some instrumentation towers and weakened supporting wires on others. The ability of the evaluation team to operate and deal with the environment will be a critical factor in NTC operations.

The environmental conditions at NTC do not duplicate those in Europe. Though extremes of weather will exist, the snow and rain conditions and limited visibility which characterize the European climate, especially in the winter, will not be present. Evaluations must therefore recognize the different conditions. As with the terrain variations, units must be evaluated on performance at the NTC, not using European conditions which are not found at Fort Irwin.

## F. PERSONNEL AND EQUIPMENT

The personnel and equipment allocations at the National Training Center are designed to provide optimum support and operational equipment to units training at Fort Irwin. The allocations are designed under the premise that deploying units will bring minimum home station equipment with them and will perform only those duties associated with preparation for, execution of, or recovery from their training mission. Only those personnel and equipment factors which relate to the evaluation process will be discussed here.

### 1. Personnel

NTC planning anticipates that more than 2500 personnel will be directly involved with the training unit [23]. Of these the majority will be members of the OPFOR unit and will play only a supporting role in unit training and evaluation. The organizational chart for the NTC operations group is

displayed in Figure 3.[6] The NTC has a unique structure in that it combines "trainers", the TRADOC element, with the "troops", cadre and OPFOR from FORSCOM (Forces Command), under the overall command of a brigadier general. Since all training troops are members of FORSCOM units the command of the post is a FORSCOM responsibility with the mission of providing a training base for applicable CONUS units. The TRADOC element is responsible for planning and execution of training for the visiting units. The integration of the two major commands at NTC is a factor which will require monitoring to assess functional effectiveness and to affirm the congruence of the operational goals of each major element.

The operations group, composed of TRADOC personnel, is responsible for conduct and evaluation of training. The two key elements within this group are the EMC (exercise maneuver control) section and the TAF (training analysis and feedback) section. EMC personnel are responsible for the operations which control the training scenario and environment such as control of OPFOR, airspace clearance, and frequency spectrum management. The EMC personnel work primarily in the data center, which is the heart of the instrumentation system.

TAF personnel are responsible for training analysis and the post-exercise training feedback given to the units.

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[6] The organization chart is derived from a briefing slide provided by the NTC TRADOC Systems Manager's Office, Fort Monroe, Va., 10 Jan 1980.

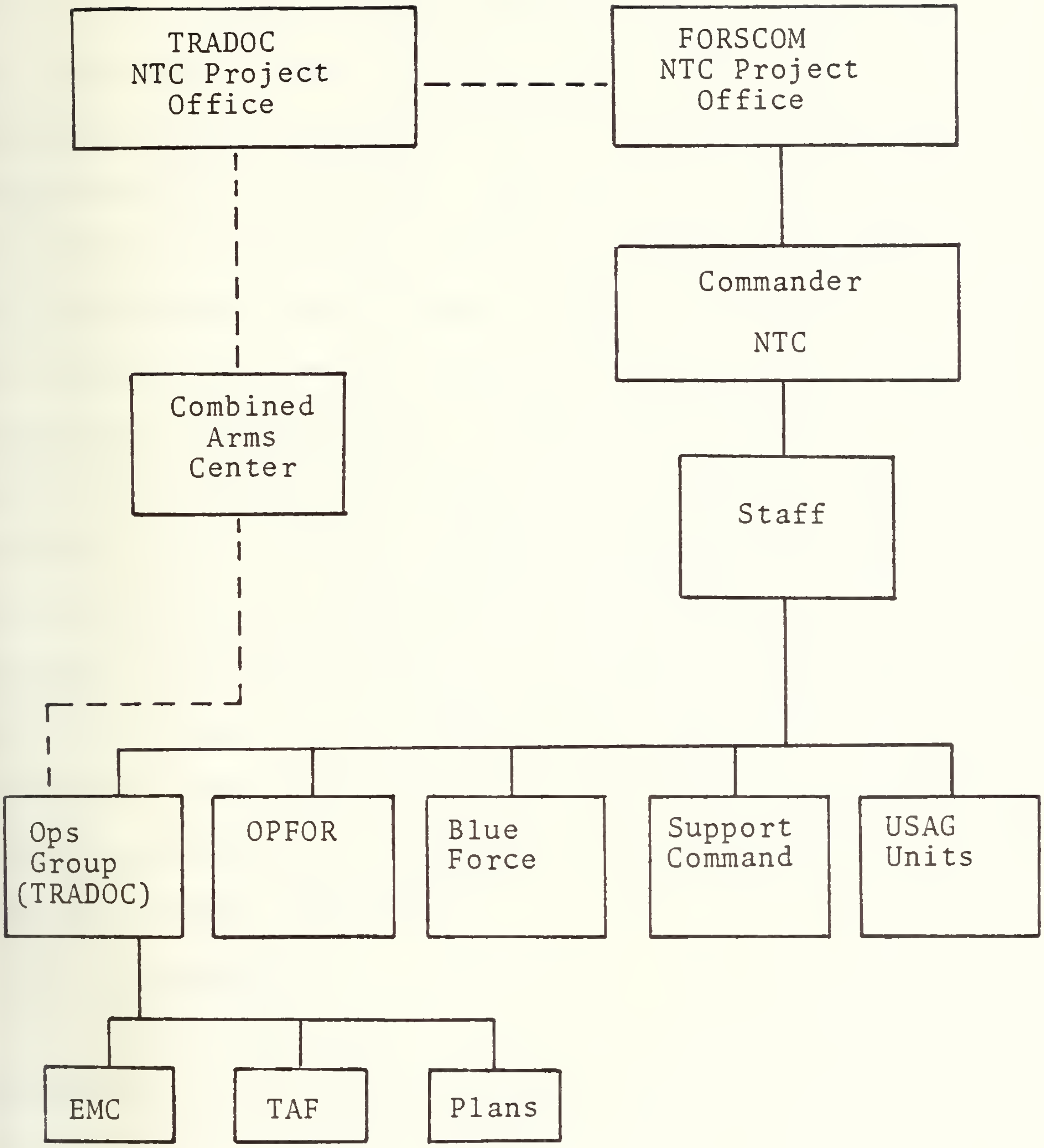


figure 3.

NTC Organization Chart

The TAF is split into two parts: the field controllers and data center personnel. These key personnel must be thoroughly trained and highly experienced. Ideally, field controllers should have command or staff experience at the level at which they evaluate. Field controllers are responsible for field maneuver control, exercise safety, and the evaluation of non-instrumented unit actions. Each training battalion will have 18 controllers to monitor operations down to platoon level and in the essential staff areas. Field controllers will supply key inputs into the unit evaluation by monitoring areas not covered by instrumentation. Data center personnel do the remote monitoring of battalion performance from the central control facility. While command experience is not as critical at this level (except for a few key observers), rigorous training and knowledge of the instrumentation is required if key actions are to be captured by instrumentation for later critique. Data center personnel and field controllers hold joint responsibility for effective evaluation, each in his area of optimum capability.

2. Equipment

Deploying units to the NTC will draw vehicles and equipment from stockpiles tailored to a particular unit configuration, designated as POMCUS stock. Four battalion sets (two armor and two mechanized infantry) will be positioned at Fort Irwin. Units will draw the equipment on arrival, use it for training, do necessary repairs and services after training, and return the equipment to NTC control. The vehicles and

major weapons systems issued will be configured with necessary instrumentation and replacement of faulty player sets will be a continuing requirement. This task will be a cadre responsibility as maintenance personnel from the training units will not have the necessary repair training. High vehicle mileage and hard use will necessitate vehicle rebuild at an accelerated rate over the Army standard and maintenance costs will be high due to the frequency of vehicle use and the rough terrain in the maneuver area.

Instrumentation equipment and player packs are more fully discussed in the next section of this paper. Because of high use factors, rough handling, and their complex nature the availability of player packs will be critical. Evaluation personnel must be aware of instrumentation status and the effects of instrumentation breakdown. Players who cannot be "killed" because of instrumentation failure must not be allowed to skew the training evaluation unnecessarily.

# III. NTC PHASE I INSTRUMENTATION SYSTEM

## A. SYSTEM OVERVIEW

The NTC Phase I Instrumentation System, when operating with all its subcomponents, completely controls the training environment in which visiting units will operate at the National Training Center. The components of the system are shown in Figure 4, along with a description of their essential functions.[7] These components, when interfaced with one another, control the scenario, the operating environment, and the evaluation of the training battalion during the six mission periods of the training cycle.

For the purpose of instrumented evaluation, five of the subsystems (each marked with an asterisk in Figure 4) are essential to the collection and processing of raw instrumented data. The term "instrumented data" is taken to include all those data elements which are automatically collected without operator interface or which require an operator only to begin or end the collection process. This data is then used in the unit evaluation, either by automatic processing into various statistics or through interpretation by TAF personnel in the data center. A complete unit evaluation requires that raw data be collected and processed from three primary sources:

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[7] National Training Center System Specification, Revision 1, p. 20, 26 Nov 1979.

instrumentation, field controller inputs, and voice transmission interpretation. The latter two sources have key roles in the evaluation process, but data collection from them is essentially a manual task of a subjective nature, affected by biases at the player and collector level. Instrumented data is objective, readily collected, and can provide insights into other data requirements. In this section, the characteristics of the essential instrumentation subsystems will be examined, as well as the objective data elements which they provide. This analysis is a preparatory step which leads to a discussion of the evaluation system and how the data elements can be incorporated into the evaluation.

## B. INSTRUMENTATION SYSTEM SUBCOMPONENTS

The five subcomponents of the Phase I Instrumentation System identified in Figure 4 control the collection and evaluation of instrumented data. As such, the function and capability of each subsystem must be examined. No attempt is made to provide detailed technical specifications, as these will be driven by operating requirements. Instead, operating needs and equipment capabilities will be discussed as they affect the instrumented data gathering process. As the Phase I technology is off-the-shelf, equipment limitations must be expected and these are discussed as they affect evaluation.

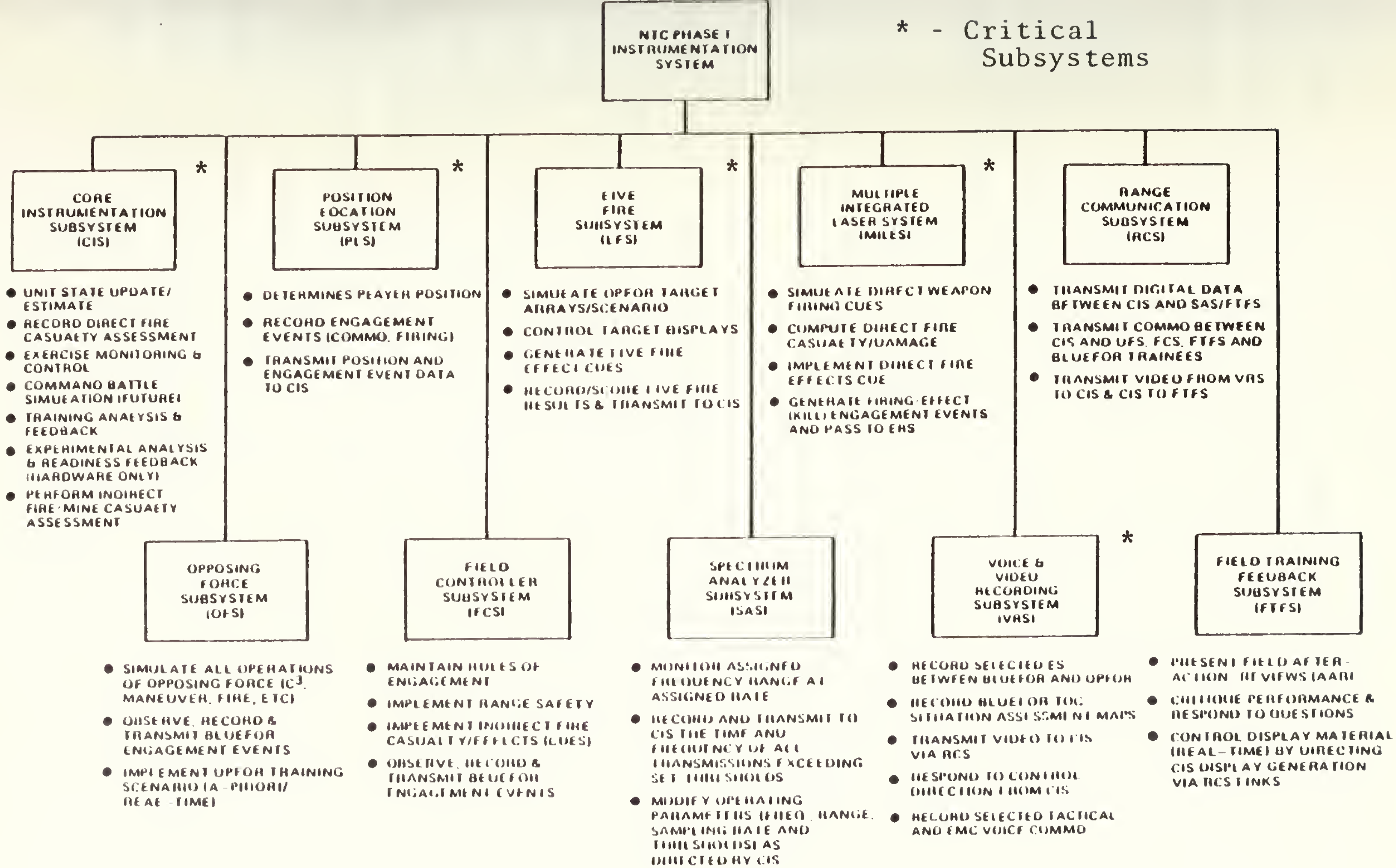


figure 4. NTC Phase I Instrumentation System

1. Position Location Event Recording System

a. System Description

The position location/event recording subsystem (PL/ERS) is one of the two chief components of what is informally termed the "on-vehicle player pack" [28]. When combined with a direct fire simulator (MILES) or an interface to the vehicle weapons system (part of the Live Fire System), the PL/ERS provides a complete record of the location and firing activities of a combat vehicle and its associated weapons during the training exercise.

The position location function of PL/ERS is designed to keep an accurate location (within 20 meters) of every combat vehicle and major weapons system within the battalion [8,11,19]. Vehicles for which PL will be kept include all tanks, APCs, and command post carriers of both friendly and OPFOR forces. Major weapons systems such as TOW which are capable of being dismounted from a combat vehicle are also tracked, as are selected personnel when they are dismounted from their vehicle. Tactical aircraft, including both Army helicopters and Air Force close air support (CAS) aircraft, are also monitored. The position location of each is updated at a rate proportional to the vehicle's rate of movement. Ground systems have an update rate of every 4-10 seconds, while tactical aircraft positions are updated at 0.1-0.5 second intervals [19].

The event recording system (ERS) complements the operation of the position location system. The ERS is coupled

both to the PLS and to the engagement system (LFS or MILES) and serves to keep a record of the key firing events of the vehicle and the hits recorded on it. Every time a vehicle fires one of its weapons, the time of firing and weapon type is recorded and sent to the central data bank. If a vehicle receives a hit from an opposing system, the time of hit, type of weapon, and effect on the vehicle (near-miss or kill) is recorded. Event data is recorded at the time of occurrence and is then correlated with the location information provided by the PLS. One of the features of ERS is that it will possess the capability to record and transmit up to eight events from systems which are interfaced with it. The draft system specifications [28] list three events which will be transmitted via ERS. These are discussed more fully in Appendix I.

The exact form of the PL/ERS is uncertain and largely a function of competing technologies [8]. Regardless of its final form, the system must have two major parts: the on-vehicle pack and a telemetry system which controls the extraction of information from the vehicle pack and its relay to the data center. The player pack has as subassemblies [19]:

the PLS system,

the ERS and an interface to the engagement system of MILES or the live fire system,

an event clock accurate to .01 seconds,

a transceiver for communicating with the telemetry system.

The telemetry system interfaces with both the player pack and the data center and must be able to poll the vehicle player packs for position location at the proper time as well as be able to relay even data as it occurs.

b. Operating Constraints

The technology limitations described below are inherent to PL/ERS and will limit the amount of data collected in some areas.

(1) Accuracy. The 20-meter position accuracy will limit the usefulness of PL data at the individual vehicle level. The potential for use of PL data in line of sight modelling, indirect fire assessment and individual vehicle tactical movement is limited.

(2) Player limitations. The size and cost of player packs limits their use to major weapons systems (tanks, APCs, TOW, etc.,), and specified dismounted personnel. The exact number and type of player u nits to be purchased is listed in Appendix D. The planned number of 500 systems does not permit instrumentation of recovery vehicles, supply trucks, and other support vehicles with functions outside the "shooting" war. Instrumented evaluation in these areas will be limited. This limitation also affects dismounted elements, where keeping PL/ERS on dismounted squads and platoons will be difficult.

(3) Limited data input. The capability of recording only eight events limits the amount of information

which can be centrally stored. The only weapons, designated "major weapons systems," for which firing data is maintained are tank main gun, TOW, Sagger, and Maverick missiles. Input data constraints will not permit PL and time records to be kept on other weapons. Hit/kill data is maintained for all weapons with a PL/ERS player unit, but not for non-instrumented vehicles or personnel.

2. <u>Multiple Integrated Laser Engagment System (MILES)</u>

a. System Description

The Multiple Integrated Laser Engagement System (MILES) simulates the fire of direct fire weapons systems and is used in the engagement simulation (force-on-force) exercises at the National Training Center. Basically, MILES consists of a receiver-transmitter combination which uses eye-safe Gallium Arsenide lasers to simulate the fire of direct fire weapons systems [9]. The MILES transmitter is a coded beam laser transmitter which is attached to the weapon whose fire it is simulating. There exists within MILES a complete weapons hierarchy, from the M16 to the TOW missile, facilitated by the beam coding. By coding the beam, being able to measure its intensity, and using logic circuits in the receiver, MILES is able to enforce proper engagement techniques for particular weapons systems and to provide realistic operating ranges and hit/kill probabilities. Typical operating ranges are listed in Appendix E [9]. The MILES transmitter is sound-activated, sending its coded beam only when a blank from the weapon is actually fired, thus

forcing logistical play and requiring weapons to be operational. MILES can be adapted to fire without blanks if necessary. In the "silent fire" mode, the transmitter employs a logic circuit which counts the number of rounds expended and enforces a mandatory "reload" time for larger systems, such as the TOW and Dragon. Sample stored basic load sizes are displayed in Appendix E. When the basic load has been expended the transmitter is disabled, preventing crews from having unrealistic amounts of ammunition on board the vehicle. Once resupply is completed, a controller re-activates the transmitter and the weapon may rejoin the fight.

The MILES receiver operates in conjunction with a group of laser detectors which are attached at prominent places on the soldier or vehicle using the MILES equipment [9]. When coded laser message pulses are received from a transmitter (the vehicle is paired with another vehicle firing its MILES transmitter), the received codes are analyzed by the receiver. The arriving pulses are compared to a threshold level. If the pulse exceeds the threshold, the weapon is in range, and a single bit is registered in the detection logic. Once a proper arrangement of bits exists (called a word), corresponding to a valid code for a particular weapon, a decision is made to determine "hit" or "near miss". Since MILES uses a single laser to transmit both the "hit" and "near miss" beams, it would be more realistic to have a larger beam size, and thus higher probability, for the near miss beam. This is accomplished in two ways. First, the

transmitter emits a smaller number of "hit" words than "near miss" words, giving a lower probability of hit than near miss. Second, the transmitter is operated at higher power when emitting near miss words, thus effectively increasing beam size.

If a "hit" is detected the receiver determines by the coding of the beam if the firing weapon can kill the vehicle carrying the receiver. Once a "hit" has been determined a simple Monte Carlo technique is used to determine vehicle damage. Uniform random numbers drawn by the receiver logic circuits are compared to pre-selected kill probabilities stored in memory circuits. If the random number exceeds the kill probability a near miss is scored, if not, a vehicle kill is recorded. The receiver will then cause audio and visual signals to be sent tothe crew to announce the hit or near miss. External indications of a kill are signalled by a flashing strobe light or ignition of a smoke grenade. In the event of a kill, the transmitter of the killed weapon is disabled and further participation in the exercise prevented.

MILES equipment will be procured by the National Training Center in the quantities listed in Appendix F [23]. Most soldiers and vehicles in the training battalion will wear a detector set (receiver), and thus will be capable of becoming a casualty. However, only major combat vehicles, weapons systems, and specified personnel will have an interface from MILES to the PL/ERS. Lighter weapons, such as LAW, M16, and the .50 cal machinegun, will use MILES in a

"stand alone" mode, unconnected to PL/ERS. Vehicle or personnel casualties caused by these weapons will be reported to the instrumentation system only if they have the PL/ERS interface.

b. Operating Constraints

MILES represents a giant step forward from the REALTRAIN/Scopes training system. The engagement/casualty assessment system offers training realism previously unavailable to Army units. As with any system, it is not perfect and requires compromise and simplification in several areas, which are discussed below.

(1) Killer-victim pairing. Because the information sent in the coded laser beam does not include vehicle number, the identification of a killer vehicle must be made by comparing clock data among vehicles or weapons of a particular type. In a heavy engagement some information may be lost due to high event rates. Additionally, the lack of PL/ERS instrumentation on lighter weapons such as Dragon and LAW, results in the loss of killer information (position, range, etc.) for these weapons. There is also significant information loss in the event of non-pairing by a firing weapons system. If a tank fires and no pairing is accomplished, no other information is available. Important information about direction of fire, target identity, possible false detections, or suppression of suspected enemy locations cannot be collected.

(2) Personnel Casualties. Assessing casualties to personnel is not a problem to MILES, but an effective system to do it is needed. When a vehicle is hit, a crewman becomes a casualty only if illuminated by the killer's laser beam. The infantry squad in a buttoned-up APC killed by a tank may exit the vehicle to fight in the battle after the vehicle is killed, when in reality all or some would be casualties. At present, the controller must make a subjective decision about personnel losses and then use his controller's gun to cause a realistic number of battlefield casualties. Additionally, because they are not linked to PL/ERS, personnel casualties are not centrally reported.

(3) Kill Probabilities. In order to simplify MILES single-value kill probabilities (P(Kill)) are used to determine vehicle status after a hit. The P(Kill) values are fixed and do not vary to reflect such factors as attack angle, range, location of hit, multiple hits, etc. Current kill probabilities are listed in Appendix G for the various weapons systems which MILES simulates [32].

(4) Gunnery Training. MILES is not intended to be a valid gunnery trainer. While basic engagement techniques are required, there are differences. For example, no lead is required when tracking moving targets with a tank gun, and no superelevation is required for long range targets. Basic tracking with the TOW is required, but engagement techniques are somewhat dissimilar from those used to fire actual rounds. The training value from MILES comes from engagement simulation,

not the duplication of gunnery techniques. The results obtained by engaging targets with MILES will not duplicate the results in a live-fire exercise.

3. Live Fire System (LFS)

a. System Description

The Live Fire System (LFS) is designed to perform two essential functions in Mission Period 6, the live fire phase of unit training at NTC [29]. The first function is the control and presentation of realistic target arrays for engagement by the maneuvering forces. The second function is the recording of event data and the transmission of the data to the data center for evaluation. In order to analyze how the LFS performs these functions it is necessary to break the system into two parts: the target system or "down range" component, and the range system, or "baseline" component.

The downrange target system is composed of remote-controlled individual vehicle and personnel targets and fire effects cueing devices which are used to simulate the presence of an enemy force on the battlefield. The remote controlled fire effects cueing devices, such as smoke generators and flash devices, are intended to enhance the realism of the exercise as seen by the participants. The key elements of the downrange system are the Swedish-designed SAAB remote controlled target systems. These systems are radio-controlled full size vehicle silhouettes which can be commanded to pop up from concealed positions to present targets to the maneuvering

unit. Each target is equipped with a visual gunfire simulator and a kill indicator which activates when the target is hit. The SAAB target has both ballistic and laser sensors and is vulnerable to both projectile weapons and to MILES laser simulators for weapons such as TOW and Dragon. Each target has an automatic scoring mechanism which has a sensitivity control to permit selection of a minimum kill threshold for ballistic weapons. For example, a .50 cal M2 Machinegun will not kill a tank, but it may kill a truck. Truck targets, therefore, can be regulated so that .50 calibre weapons and above can destroy them. Each SAAB target contains a receiver-transmitter (R-T) for communications with the baseline range operating system. Over this R-T, commands will be received to elevate the target and/or fire the gunfire simulator, and the R-T will transmit hit data back to the baseline.

The target arrays will be set up in the live fire area (see Figure 2) at Fort Irwin. Because the SAAB systems are portable, different configurations may be used to portray different OPFOR units, tactics, and missions. A system test, conducted at Fort Hood, Texas in January 1979 to validate the training concept, serves as an example of a defensive scenario [31]. In the test a reinforced motorized rifle battalion (MRB) was portrayed as attacking a tank-heavy company team. 195 SAAB tank targets and 60 dismounted infantry targets were used to portray the MRB. The targets were arrayed in seven belts which were placed at ranges from 4000 meters inward to 380 meters from the company position. In the seven belts the

enemy units were depicted as moving from a march column formation to an assault of the company position. The targets were exposed in a manner consistent with the attack speed of an OPFOR unit, the bulk of engagements being closer than 3000 meters. OPFOR casualties were assessed in real time as fewer targets were presented in succeeding belts, according to gunnery results. This exercise illustrates, on a small scale, how the target area may be designed to portray a typical mission situation.

The control of the downrange target system, the collection of target data, and the relay of this data is accomplished by the range control system, as illustrated in Figure 5 [29]. A mini-computer is the heart of the system. The mini-computer executes a stored program to display targets in a particular sequence. The program relays target commands to the transmitter console (target control unit) which controls the target array. The program is revised in real time to adjust the arrays for targets which have been killed and reported over the VHF net. The mini-computer also stores the time-sequenced target data and relays it to the central data center for integration with other evaluation data.

The Live Fire System constitutes only one-half of a live fire exercise. It portrays the stimulus event to the training unit and records the results of the unit's action, but not the action itself. The units' actions are traced

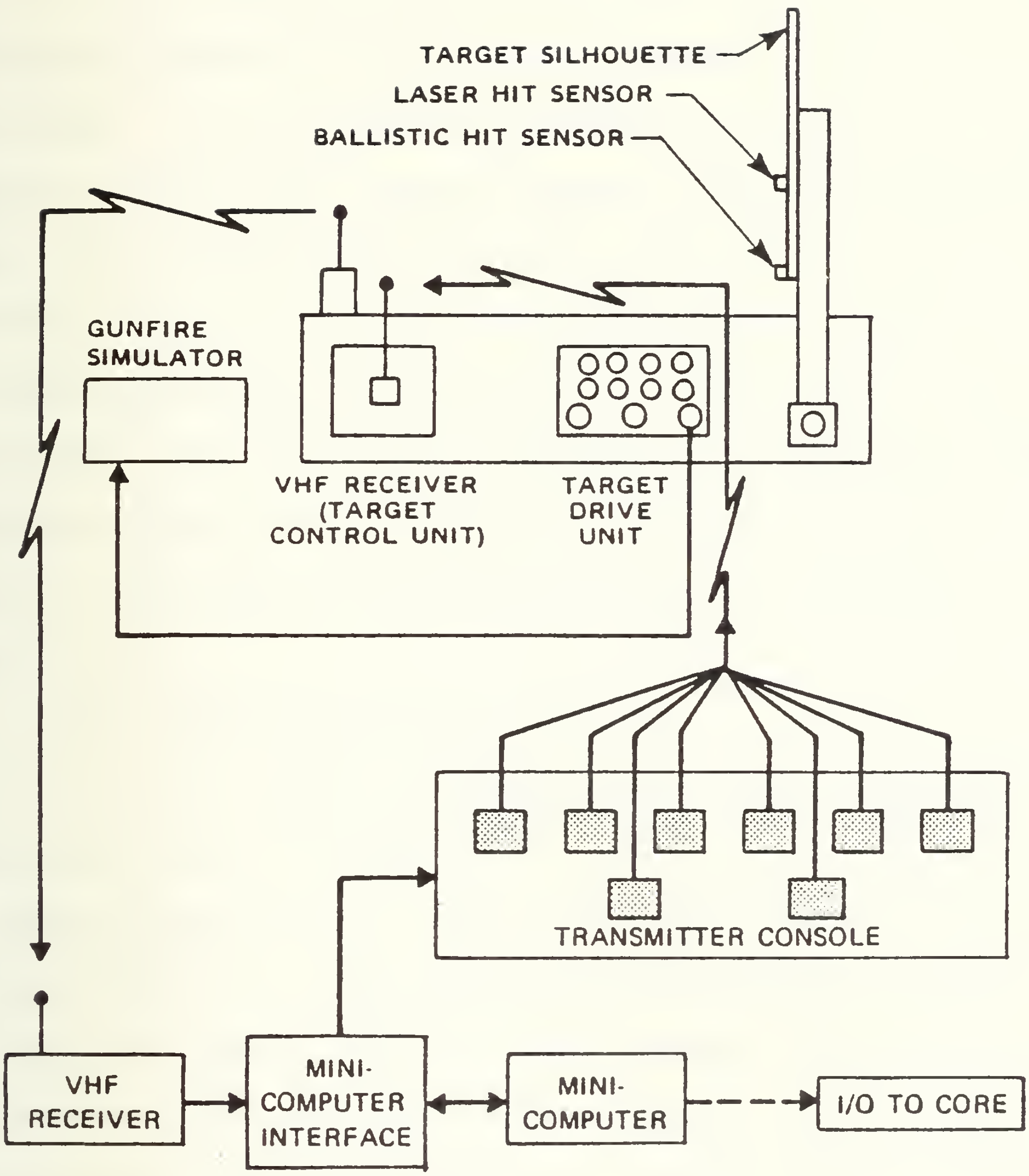


figure 5.

Live Fire System Range Control Unit

through a weapons system interface (WSI) to the PL/ERS. For TOW and Dragon, the weapons system interface is MILES, since the use of actual missiles would be prohibitively expensive. For ballistic weapons, such as the tank, an interface box is connected between the fire control system of the vehicle and the PL/ERS. The interface is keyed by the firing of the vehicle weapons and reports weapon type fired and ammunition used. Like the MILES-PL/ERS link, only firing and position data for the major weapons systems (tank gun and TOW) will be time-sequenced and reported to the data center. At the data center both the time-sequenced firing data and target data are correlated and a coherent picture of mission results appears. Pertinent evaluation can then be conducted on the data.

b. Operating Constraints

(1) Killer-Victim Pairing. The most apparent problem in the LFS is the correlation of killer-victim data. The SAAB system can not report the type of the killing weapon, nor its identity. Likewise, the weapons system interface box does not indicate the intended target. Because of the delay caused by projectile time of flight, improper matching of the killer with the target will distort the data somewhat. As with the MILES subsystem, weapons with no PL/ERS capability may kill targets, but no record appears in the data stream.

(2) Employment of Artillery. The employment of live artillery in the downrange target area is an issue which affects the live fire system. In the live fire concept

evaluation [31] the use of 155 mm artillery resulted in target kills from shrapnel and concussion effects which would not have disabled actual vehicles. Additionally, the close impact of high explosive rounds caused unacceptable damage to exposed target mechanisms. Shielded target mechanisms suffered no damage, but the 600-pound shielding prevented normal maintenance on the target and eliminated the man-portability of the targets.

The solution to the problem perhaps lies in the use of white phosphorous (WP) or base-ejecting smoke rounds in the target area, since these rounds have negligible explosive effect. The use of an artillery simulation (discussed in the section on the CIS) similar to that proposed for engagement simulation has the disadvantage of requiring a downrange fire marker to locate spotting rounds. This would entail an unacceptable safety risk to control personnel. For the purpose of this paper, it is assumed that WP or smoke rounds will be used in the target area, and their burst pattern is simulated by a computer program which assesses vehicle damage in the downrange area.

(3) Assessing Friendly Casualties. The TCATA live fire concept evaluation did not assess casualties to the friendly unit. This practice undoubtedly affected engagement results to the advantage of the maneuver unit, since a uniform amount of firepower was available throughout the live fire problem. A decision regarding the training benefit of

this approach must be made prior to IOC for Fort Irwin. The issue must balance the tradeoff between lost training for killed elements against the added stress and the need for flexibility which is placed on the unit commander in a casualty situation. This paper assumes that no friendly casualties are assessed during the live fire phase of training.

4. Core Instrumentation System (CIS)

a. System Description

The Core Instrumentation System (CIS), previously cited as the "data center", is the heart of the system which controls both exercise scenario and battalion evaluation. The CIS is physically located near the cantonment area at Fort Irwin. Its functions are to control the maneuver training, serve as a central data reception/processing station, perform indirect fire casualty assessment, and be the central agency for training analysis and feedback [27].

The CIS is literally the center of the instrumentation system. It interfaces with or controls all of the other Phase I subsystems. The exercise maneuver control (EMC) and Training Analysis and Feedback (TAF) sections, discussed previously, are collocated with the CIS and are the main operators of the CIS. The equipment utilized in the CIS includes four mini-computers, disc and tape drives, and other related equipment. The EMC and TAF sections are hooked into the CIS via a group of interactive terminals and the sections have the capability to input and manipulate the data stored in the computer. The CIS is also directly linked to PL/ERS and receives and processes its position and event data.

The CIS offers two distinct advantages which aid battalion evaluation. First, its use of interactive computer colorgraphics allows the EMC and TAF sections to "see" all or selected parts of the maneuver unit as well as the OPFOR as they perform their assigned missions. The storage of Defense Mapping Agency (DMA) digitized terrain in the CIS and the input of unit graphic control measures allows prominent terrain and the proposed unit scheme of maneuver to be displayed to TAF personnel. A broad, overall picture which complements the observations of the field controllers emerges, and a maneuver record is preserved for later review and critique by the training unit. The second advantage offered by CIS is speedy central data management. Millions of data elements are processed into various statistics which can be manipulated by TAF personnel to give a clear view of unit performance.

An important subsidiary function of CIS is the assessment of indirect fire casualties. The use of supporting artillery and mortars by the combined arms task force is a key ingredient in the battlefield success of the battalion. Since actual rounds can't be fired during force-on-force exercises, a simulation is developed which will portray the effects of artillery and mortars. Firing data is received by the CIS from the DS artillery supporting the battalion. Since battery positions are known, a projectile flight path and ground burst pattern can be simulated by the computer. By checking the updated vehicle position location, casualties

can be assessed against vehicles in the bursting radius according to known P(Kill) for artillery weapons. This information is then relayed by CIS via PL/ERS to the player vehicles.

Indirect fire casualty assessment is a valid concept which is technologically difficult to execute. The difficulty lies not in the work done by CIS, but in realistically portraying the role of the forward observer in the target acquisition and adjustment process. Adjusting rounds must be placed on actual grid locations so that corrections may be made, and range/location errors must be allowed to occur. Additionally the portrayal of artillery effects to the player units is difficult.

b. Operating Constraints

Operating constraints for the CIS are very much hardware driven. Since the exact hardware specifications are not known, operating constraints are difficult to assess precisely. The layout of the EMC/TAF, the functional flow of information, and responsibility of individual personnel must be carefully designed to handle the large amounts of input data and the ensuing evaluation requirements. The TAF section will work 3-5 minutes behind actual maneuver time in order to allow processing time for the computer. Since their function is evaluation, not real-time control, this poses no real problem.

5. <u>Voice and Video Recording System (VRS)</u>

a. System Description

The Voice and Video Recording System (VRS) has the function of recording significant events which occur during the training exercise [25,26]. These events include key radio transmissions, TOC operating procedures, tactical assessments as portrayed on battle maps, and sample tactical maneuver events. These events are recorded and then analyzed and input into the data bank to be used in the evaluation of the battalion. VRS will monitor all tactical nets (command and fire support), as well as specified administrative nets on which the battalion operates.

Since this paper deals primarily with data supplied by instrumentation and manipulated by the CIS, the voice recording system will not be extensively analyzed. VRS provides an essential recording service which allows evaluators to replay to the unit the message traffic which occurred in an action and to gather data about the situation as it was perceived at the unit level. In the analysis of the evaluation system it will be assumed that the TAF personnel have access to the information contained in the messages which are passed over unit radio nets. This hypothesis bypasses the message processing issue and assumes that radio traffic can be broken down and efficiently disseminated to TAF personnel.

b. Operating Constraints

As with the CIS, the functional breakdown of responsibilities within VRS will be a key element. There are

over fifteen tactical nets in a battalion, making the monitoring, collection, and cueing functions complex activities. The flow of information must be complete and yet controlled so that the evaluation personnel can respond accurately and quickly to the actual field situation. Unit jargon, non-standard radio procedures, and the effects of communications jamming are factors which will reduce the effectiveness of VRS, since unit radio transmissions must be manually screened for criticality and entered into the computer data banks by VRS personnel.

## C. INPUTS TO THE INSTRUMENTATION SYSTEM

The workings of any evaluation system dictate that there be a conversion of raw input data, regardless of type, into performance measures according to the specific nature of the evaluation system. Before a meaningful evaluation system can be designed the source of each element of raw data must be examined and classified. In this section the various elements of the maneuver battalion and the OPFOR unit are analyzed and matched with the subsystems of the instrumentation system. In this way the data input elements from each vehicle and weapons system are defined so that a specific evaluation system may be designed to use all available information.

### 1. Distribution of Instrumented Equipment

The distribution of instrumented equipment to the player and control elements at NTC is listed in Appendix H.

This appendix pinpoints the location of instrumented equipment within the battalion and its supporting elements, and that possessed by the OPFOR unit. Since the exact support slice to accompany each battalion varies depending on the unit, generalized supporting elements are described. Standardized tables of organization and equipment (TOE) are used to locate the various vehicles and weapons systems within each organization [6,13]. The equipment in each unit is described according to the level of instrumentation it possesses. Instrumentation levels are:

| | | |
|---|---|---|
| PL | - | possesses position location equipment, |
| ERS | - | possesses ERS and MILES detector set, has no MILES transmitter connected to ERS, |
| MILES/ERS | - | possesses complete MILES equipment and is interfaced with PL/ERS subsystem, |
| MILES | - | possesses complete MILES, but with no PL/ERS interface, |
| WSI/ERS | - | live fire weapons system interface from vehicle weapons system to PL/ERS, and |
| CIS | - | possesses capability to input to CIS indirect fire information for casualty assessment. |

The equipment is listed in Appendix H according to the "pure" form of the battalion. At the NTC battalions will operate as task forces, exchanging one line company for either a tank or mechanized infantry company to capitalize on the advantages of combined arms. The capabilities and locations of the equipment

should be noted, and an equipment recap provides aggregated numbers for the battalions when configured as task forces.

2. Instrumented Data Input

Appendix I lists the individual elements of instrumented data which are supplied to the CIS during engagement simulation (force-on-force) and live fire exercises. These data elements are products of the interactions between PLS/ERS, MILES, LFS,and the CIS. No refinement or manipulation of the raw data is attempted, since this is the function of the evaluation system. The intent of Appendix I is to show the form of the raw data at its input level, so that the steps necessary to transform the data from its input state to final form can be better understood. In reviewing Appendix I one must remember that time is expressed in intervals accurate to 0.01 seconds and that locations are accurate to ±20 meters on the x and y axes and to ±10 meters on the z axis (altitude).

# IV. EVALUATION METHODOLOGY

At the National Training Center units will train using the TRAIN-EVALUATION-TRAIN methodology [18,23] in which unit performance is critiqued after a training exercise, and then remedial training will be applied to correct deficiencies. The evaluation process is a critical part of the training methodology. It provides a gauge of unit performance and an indicator of areas which need remedial work. One of the goals of NTC is to provide an objective evaluation as a means of improving unit performance. In the light of the previous discussion on the role of evaluation (Section II, Part B, Paragraph 2) it is assumed that the evaluation process at NTC tends toward the "diagnostic" portion of the evaluation continuum and has as a primary goal the improvement of unit performance rather than a test of unit proficiency [23,24,25]. In this section the current methodology for developing unit performance measures is described, along with a discussion of assumptions implicit in the development process.

## A. CURRENT EVALUATION METHODOLOGY

Current evaluation methodology emphasizes the battalion task force as the focus of the evaluation. The evaluation methodology uses a top-down approach which takes broad tactical mission statements and decomposes them into progressively lower functional subdivisions until quantitative measures of performance (MOP) can be applied directly [18,23]. Figure 6

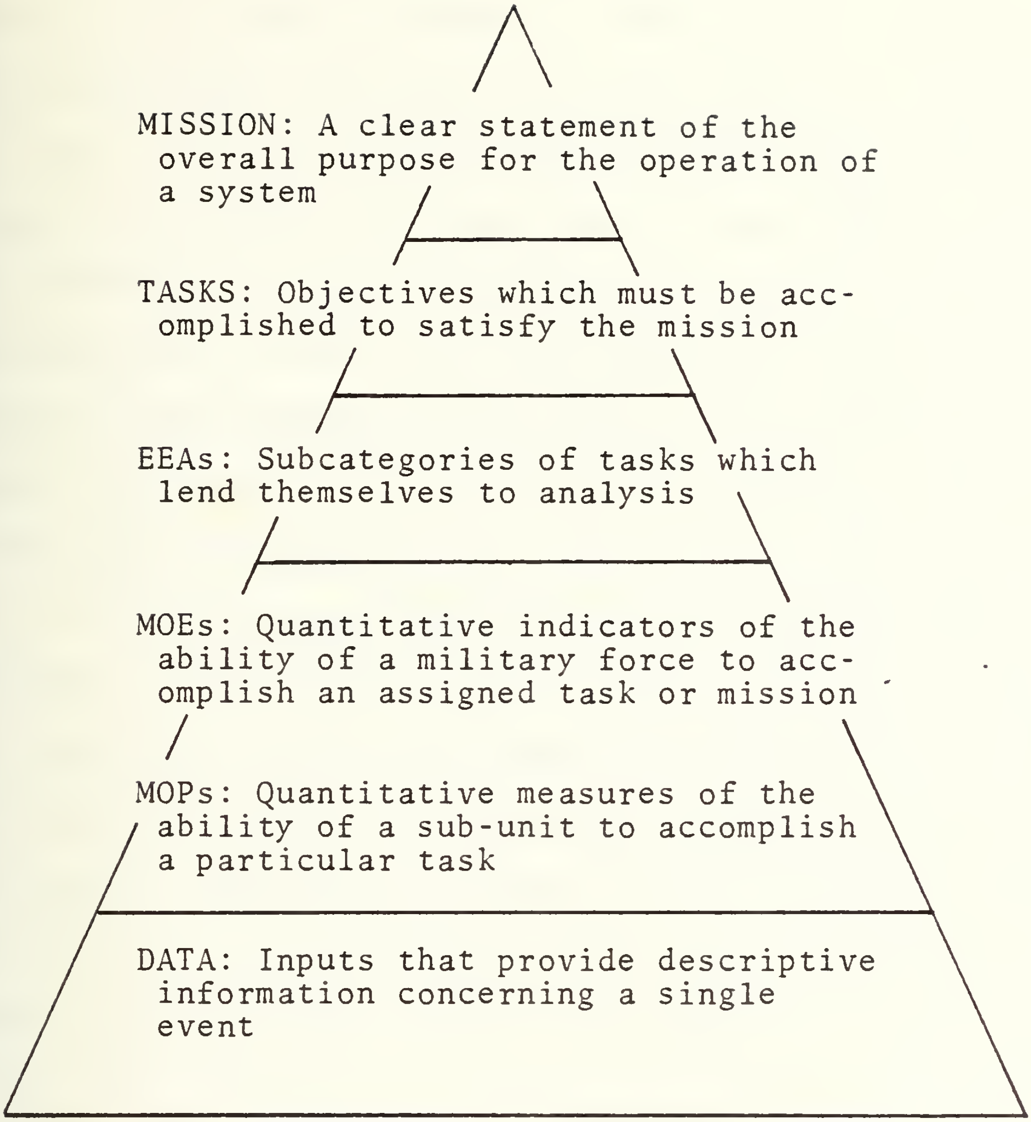


figure 6.

Hierarchy of Analysis

shows the hierarchy of analysis and defines the various subdivisions. A simple example to illustrate how the process works is illustrated in Figure 7. The analysis technique is derived from Army operational test and evaluation methodology [12] and is similar to that used to develop the tasks, conditions, and standards which are used in Army ARTEP's. The only difference in the two analyses is the availability of instrumentation at NTC. The instrumentation package at NTC allows for development of more detailed and objective performance measures for evaluation of the battalion task force.

The bulk of the evaluation analysis has been conducted by the U.S. Army Combined Arms Training Developments Activity (CATRADA) in conjunction with the service schools. Their input has been collated and appears as Reference 18. CATRADA has identified 8 EEA's, 69 MOE's, and 1829 MOP's in their analysis. The analysis considers all inputs to the evaluation process, and addresses instrumented data, VRS analysis, and field controller (manual) inputs across a non-specified mission spectrum.

## B. ASSUMPTIONS UNDERLYING THE EVALUATION METHODOLGOY

An examination of the evaluation methodology must begin with a discussion of the theory of combat. Combat, when viewed from a systems standpoint, relates a series of combat outcomes to a group of inputs through the interaction of a number of combat processes.[8] As illustrated in Figure 8, the inputs to combat can be thought of as independent variables which are

---

[8] The discussion on the nature of combat was influenced directly by Dr. James Taylor of NPS and references 1 and 10.

| SEQUENCE | EXAMPLE |
| --- | --- |
| Mission/Task Analysis | Movement to Contact |
| ↓ | ↓ |
| Specify Organization level | Platoon |
| ↓ | ↓ |
| Identify EEA | Maneuver<br>How does unit move under fire? |
| ↓ | ↓ |
| Develop MOE | Move under direct fire |
| ↓ | ↓ |
| Develop MOP | Number of tanks killed during move |
| ↓ | ↓ |
| Data Requirements | Number of platoon tanks killed from Time 1 to Time 2 |

figure 7.

Sample Development Process for MOP

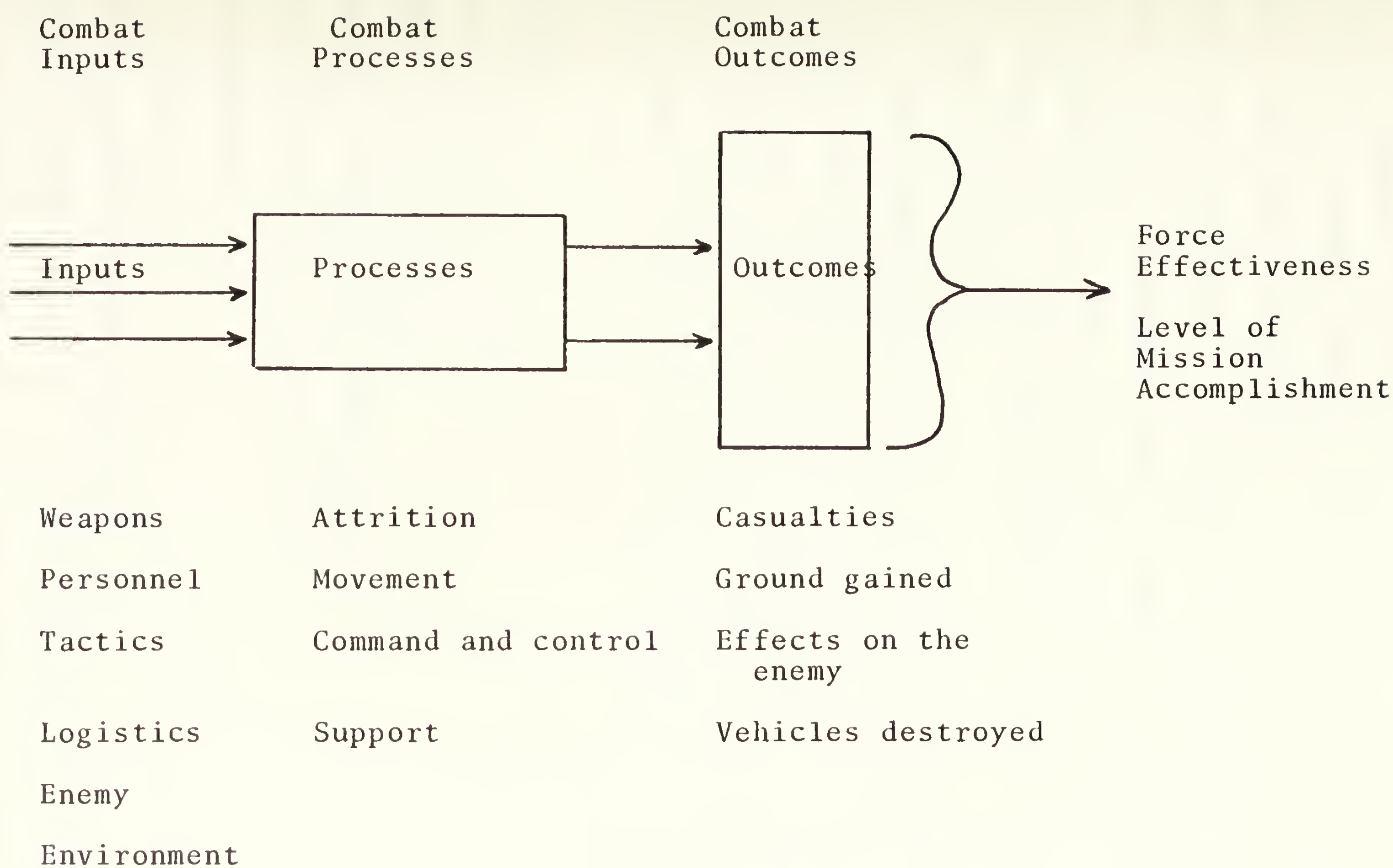


figure 8.

A Conceptual View of Combat

acted upon by combat processes to produce various outcomes. These combat outcomes are interrelated and must be combined to produce a measure of unit effectiveness or, alternately, a level of mission accomplishment. This process is neither simple nor completely understood. In analyzing the nature of combat there is a tendency to attempt to relate combat outcomes directly to the system inputs, because the two are more readily quantifiable. There is, of course, a relationship between the two, but this relationship is governed by the various combat processes.

The top-down analysis for NTC, with its EEA/MOE/MOP methodology, has produced measures of performance which relate to all three parts of the combat system - inputs, processes, and outcomes. The eight essential elements of analysis (EEA) selected for the NTC performance analysis were:

maneuver,

mobility/counter mobility,

combat service support,

command, control, and communications,

intelligence/counter intelligence,

fire support,

air defense, and

nuclear biological and chemical.

These EEA are inherently broad and allow measures of performance to be developed and catalogued from all three parts

of the system without having to identify them as inputs, processes, or outcomes. If one were interested only in measuring unit effectiveness it would be necessary only to combine the relevant combat outcomes into a measure of force effectiveness. However, since NTC is a training ground, the factors which contributed to a particular combat outcome are important. Hence, investigating the inputs and combat processes is also important at NTC because they supply information about why an outcome occurred.

Adding to the analysis problem is the complexity of the unit being evaluated. Within each of the combat processes (attrition, movement, etc.) taking place as a battalion executes a particular mission, there are a number of different types of activity which are simultaneously occurring. Some of these are [23]:

Execution - move, shoot,

Control - lead, direct,

Coordinate - synchronize,

Support - maintain, supply,

Plan - anticipate, react, develop.

These sub-levels are contained in all the combat processes, as well as in the inputs and outcomes of the system. All of these sub-levels which are relevant to battalion performance must be examined. An added dimension requires that the relevant processes be examined for the various echelons (platoon, company, and battalion) within the unit. The output of this multi-dimensional analysis is the MOE/MOP which describe the

parts of the combat system. Once developed, these MOE/MOP are then interrelated. When applied to a battalion exercise they provide a true picture of mission results, unit performance, and the reasons for that performance.

The NTC goal of objective evaluation imposes an additional burden on the performance analyst. Objective MOE/MOP must effectively measure performance, quantitatively if possible. Unit evaluators must then be able to collect data on these performance measures during training. Of the 1829 measures of performance listed by CATRADA [18] over sixty percent require manual collection by either the VRS operator or the field controller. The collection of this much data and its efficient evaluation for an after action review poses an information problem which must be solved. Conversion of some of these measures to collection by fully instrumented sources for subsequent processing by the CIS would reduce the overload. Additionally, the large numbers of performance measures result somewhat from the limitations of the instrumentation used in Phase I. An analysis of the Phase I instrumentation and suggestions for expansion of its coverage is the subject of the first part of the next section.

The complexity of the evaluation problem and the capabilities of the instrumentation have forced CATRADA to adopt certain limiting assumptions in order to simplify the analysis. These assumptions are described below.

1. Mission Similarity

Early in their analysis effort CATRADA identified many MOE/MOP as being common to a number of tactical missions. Therefore, a "shotgun" approach was used to develop MOP without relating them directly to a specific mission to be performed at NTC. The technique was also designed to reduce the problem of software design for the CIS as common MOP could be used across the mission spectrum.

2. Non-Specific Essential Elements of Analysis

The previous discussion of the theory of combat made a distinction between inputs, combat processes, and combat outcomes in the combat system. Theoretically, each of these areas would be sub-divided into different categories and have different EEA. The CATRADA analysis used eight EEA to describe the various categories in the three system areas. MOE/MOP were then forced into the eight categories without being identified as being inputs, outputs, or combat processes. This simplifies the collation process but complicates the process of separating MOE/MOP into the "input-process-output" categories necessary for later analysis.

3. Commonality of Performance Measures

Because of the similarity in unit equipment and mission scenarios it was assumed that performance measures would be common across differing unit types. The tank-heavy task force and mech-heavy task force have similar equipment and theoretically similar tactical philosophies [2,4], so identical performance measures were developed to evaluate both

types of units. Common performance measures are also used to evaluate both live fire and engagement simulation exercises at the NTC. An examination of Appendix I reveals that the instrumented data elements are very similar in both types of training scenario. This similarity was broadened to include the assumption that neither tactical behavior nor unit evaluation would be changed by the presence of live ordnance and the inanimate target systems used in the live fire phase.

## V. ANALYSIS OF THE INSTRUMENTATION AND EVALUATION SYSTEMS

The discussion of the methodology used in the development of the evaluation system for the National Training Center completed the first goal of the paper - an examination of the operation principles, instrumentation system, and unit evaluation process proposed for the NTC. The second goal, an analysis of the instrumentation and evaluation systems, will be accomplished in two parts. The first part looks at the instrumentation system and its output and suggests improvements which attempt to obtain more data from the instrumentation and thus lessen the burden of manual evaluation. In the second part, an alternate method is suggested for developing evaluation measures. An analysis is used which re-packages existing MOE/MOP in an attempt to evaluate their effectiveness and suggests a way to expand the evaluation process to improve its method of assessing the battalion and its supporting elements.

### A. THE INSTRUMENTATION SYSTEM

In examining the contributions of the Phase I instrumentation system to the evaluation process it is convenient to separate the analysis into two sections. The first examines the distribution of the instrumentation hardware and emphasizes how the placing of equipment affects the evaluation which can be performed on the unit. The second section examines

the actual data elements which are collected by the field hardware and how these inputs may be modified to improve evaluation.

1. Location of Instrumentation Hardware

Appendix H details the distribution of instrumented systems in both BLUEFOR and OPFOR units. As expected, position location equipment is concentrated on fighting vehicles and in command and control elements. These elements are most important in combat and are the focus of most of the evaluation effort. The mounted combat elements (tanks and APCs) and attendant major weapons systems (main gun and TOW) are adequately instrumented in that position location and event data (of some form) can be extracted from them. The shortfall in instrumentation hardware occurs with the support elements, infantry squads, and Dragon crews. At present there is no PL/ERS on any of the battalion support elements, whether they are maintenance, mess, or supply assets. These vehicles will use MILES detector sets only. In exercises of more than 12 hours duration or those which cover extended distances, the performance of battalion support elements is an important factor in battalion success. This is especially true in exercises which feature heavy contact where ammunition expenditure, fuel consumption, and vehicle losses are high. Instrumentation which can monitor the position and activity of support and maintenance elements can aid evaluation, especially since only one controller is dedicated to the evaluation of support assets [23].

The lack of instrumentation is also apparent with the infantry squads and the Dragon crews of the infantry and scout platoons. When infantry squads are dismounted and away from their carriers, which contain the PL/ERS equipment, they are traceable only through field controllers. Dismounted activities, such as squad patrols, raids, and the manning of OP/LPs can not be automatically traced. In the same way, the actions of the infantry and scout platoon Dragon crews are lost to data collection. The Dragon, whether mounted or dismounted, is not tracked by PL/ERS. The Dragon can make a contribution to the battle in that it has a stand alone MILES capability and can kill out to its effective range of 1000 meters. The Dragon deficiency is best understood in the context of its role in the infantry company. Aside from two TOWs and the short range VIPER/LAW systems, Dragon is the only tank killer employed by the infantry company. In an active or strongpoint defense, where the squad and its Dragon might be positioned away from its carrier, little data can be collected on these elements. The CIS will receive a message from a vehicle which is killed by a Dragon, but it cannot pair this information with a firing weapon. Firing location and crew identity are thus lost.

The solution to the need for instrumentation in the support elements and the infantry squads is obviously the procurement of additional PL/ERS equipment. However, its costs must be measured not only in terms of additional field equipment, but in the impact on the CIS of additional data

processing and performance evaluation. With this factor in mind the following modifications are suggested:

a. Instrumenting with PL/ERS the chief battlefield support vehicles. These would include: M88 VTRs of the tank battalion, M578 Recovery Vehicles in the infantry battalion, and selected fuel tankers and ammunition trucks of the battalion support platoon. By instrumenting only the major support vehicles the CIS can track the flow of support action without instrumenting every support vehicle. Because these vehicles do not need continuous monitoring a polling rate of once every 15-30 seconds is sufficient. The ERS would initially report only if the vehicle were killed, but additional information could be reported if unused message statements from the ERS (discussed in Part 2 of this section) were utilized. The additional messages from ERS would allow reporting of vehicle cargo status, time of fuel pumping for tankers, and vehicle status. The additional support data supplied to CIS would require a dedicated support evaluator and a software package to assist him in his evaluation.

b. Re-Allocation of Manpack PL/ERS Equipment.

Appendix D lists 110 manpacks as planned for NTC. These are chiefly required for dismounted commanders, video crews, and control personnel. The manpacks of PL/ERS units could be distributed in the following manner for a two battalion exercise:

| | |
|---|---|
| 1 per infantry squad vehicle (One per squad/Dragon, one per platoon HQs) | 36 |
| 1 per Scout platoon Dragon team | 8 |
| 1 per battalion command element | 2 |
| 1 per maneuver company headquarters (mech inf and CS companies only) | 8 |
| 1 per GSR team | 8 |
| Controllers | 27 |
| OPFOR, special purpose | 10 |
| Spares | 11 |
| TOTAL | 110 |

A re-allocation in this manner has a number of benefits. Most importantly, it puts Dragon systems into the ERS stream. Its data inputs would be identical to those for TOW, permitting better assessment of the use of Dragon. The re-allocation permits better tracking of dismounted combat. Since personnel casualties are not logged, some of the manpacks would need only PL capability. These would include the manpacks for controllers and command elements. Slower polling rates for position location are also feasible depending on predicted movement rates. The need for a manpack for the ground surveillance radar sections is justified by the fact that when in operation, GSR teams are normally separated from their vehicle by some distance. PL on the radar sets allows an evaluation of radar placement and coverage.

The additional coverage gained by re-allocation of manpack PL/ERS equipment is gained at the expense of some of the controller PL. The requirement for controller position location is driven by a need for EMC contact with the controllers in order to assist in orienting them for effective evaluation. Also, the positioning of artillery fire markers is aided by an accurate position location. Given the fact that controllers will become intimately familiar with the maneuver area and scenario from repeated experience, this PL requirement may not be valid. However, the fire marker PL requirement will remain until pyrotechnics and artillery simulation procedures can be improved to solve the problem of providing realistic artillery effects.

2. Expansion of Data Collection

In this section the characteristics of the data elements will be analyzed with a view toward possible changes in the instrumentation or data elements which would provide more information to the TAF evaluation team. Appendix I lists the raw data elements which are collected by Phase I instrumentation. They are broken into four basic groups: position location, firing/attrition event recording, special event recording, and indirect fire casualty assessment. The first three groups are primarily dependent on PL/ERS, while the last operates through the CIS.

a. Position Location

In analyzing position location requirements, the emphasis is placed on determining the elements which need to

be tracked and required accuracy of location for them. The first part of this section discussed the distribution of instrumented equipment and suggested modifications to the allocation scheme. The modified allocations would allow the tracking of all major combat systems in detail, while simultaneously providing information on the flow of the support activity. This allows emphasis to be placed on important combat events without neglecting important support operations.

The accuracy required for position location is ±20 meters [28]. Given the simplified vehicle casualty assessment routines used in MILES and the display capabilities of present computer colorgraphics, this accuracy is sufficient for training evaluation. However, development of sophisticated detection and line-of-sight (LOS) computer models at NTC could force a requirement for better PL as well as more sophisticated terrain data. Detection and LOS modules are important for unit evaluation in that they determine when a unit <u>should</u> have detected or fired upon an opposing force. CDEC has conducted validation efforts for a series of intervisibility models [14,15,16]. CDEC attempted to match the results of specific physical detections and line of sight measurements with the results predicted from three well known computer models voer varying types of terrain. Their experiment showed generally poor correlation between the two. The disappointing results obtained in the validation effort indicate that methods other than simulation might yield better results in the detection problem. This question requires

further study and as yet places no demand for increased accuracy of position location at NTC.

b. Direct Fire/Attrition Event Recording

The largest numbers of data elements supplied by instrumentation concern vehicle firing and attrition events. In engagement simulation this data is derived from MILES and sent via the ERS to the CIS for processing. In live fire, attrition data is reported by the range control system to the CIS while firing data is supplied either by the weapons system interface (WSI) to the ERS for projectile weapons or by MILES/ERS for the TOW. This analysis will distinguish between firing and attrition data and first analyze each type separately and then examine the interaction of the combined data elements.

The firing data supplied to the CIS by either MILES/ERS or WSI/ERS considers only what can be termed "major weapons systems." These include the main gun for tanks, the TOW for APCs and attack helicopters, the Sagger for BMPs, and the Maverick missile for CAS aircraft. The argument for including Dragon as a major weapon system with PL/ERS capability has already been discussed. The selection of these weapons accounts for most of the vehicle killing capability within BLUEFOR and OPFOR forces with several important exceptions. Aside from Dragon, the exceptions consist of secondary armament on the TOW/Cobra (a 20mm cannon), the BMP (a 73mm gun), the A-10 (a 30mm cannon), and conceptually the XM2

Infantry Fighting Vehicle (a 25mm cannon). These weapons are all capable of killing at least APC-type vehicles at extended range but are not given ERS interface on a cost and use basis. Instrumenting these weapons would increase the cost for player units and the CIS processing load. Also, theoretically, the primary weapons would be most often used against other instrumented vehicles, and monitoring them is most important. This argument is somewhat tenuous and will require additional examination, especially in the case of the IFV, where the exact employment doctrine for 25mm Bushmaster cannon has not been published. Adding a second weapon to the event recording is technologically feasible, requiring only a modification of the MILES and the use of additional event messages.

ERS does not monitor weapons of .50 caliber and below. The abundance of these weapons on the battlefield makes the task prohibitively costly in terms of both money and computing time.

The firing data supplied to the CIS for live fire exercises closely parallels that supplied in ES. The WSI/ERS does not have the capability to report the main gun ammunition type used by a tank, so standardized use of one type of main gun ammunition is necessary if the CIS is to use projectile time-of-flight to correlate gun-target data. HEAT-TPT, because of its smaller range safety fan, is probably the best choice. As with MILES/ERS, secondary and small caliber weapon firing is not reported to the CIS.

On the target half of the gun-target combination, MILES/ERS is also responsible for assessment of vehicle casualties and their reporting to the CIS. MILES is the primary system for assessing vehicle attrition. When its receiver detects a hit by a weapon which can kill the target vehicle, a Monte Carlo process determines if the hit caused a kill. A vehicle kill is sent to the CIS through the ERS. If either the weapon was not lethal enough to kill the vehicle or the Monte Carlo process did not produce a kill, a near miss is registered and sent to the CIS. The weakness of this system lies in the fact that the MILES is not a range dependent system and the attrition process uses only a single number for kill probability. Thus, many factors which affect the actual kill probability, such as range and angle of penetration, are not portrayed. These simplifying measures will distort the loss rates somewhat. From a cost/effectiveness standpoint, this system is acceptable for NTC. The MILES system used at NTC is only a modification of the equipment that will be used all over the Army in a stand alone (no PL/ERS) mode. The economies of scale which result from Army-wide procurement and commonality of MILES equipment offer a powerful argument to balance against possible benefits deriving from development of a different engagement simulation system.

The attrition process utilized in live fire scenarios is controlled by the range control system (RCS). As illustrated in the lower half of Figure 5, the RCS consists of

a mini-computer and a target control unit (transmitter). The RCS is alerted when a target is hit or killed and relays this information to the CIS. A probability of kill as such is not played by the RCS on a round-by-round basis. The SAAB targets downrange can be preset for a kill threshold and for the number of hits required to produce a kill. In this way different kill probabilities can be selected for various targets. The live fire attrition system yields less data on vehicles casualties than is available through engagement simulation. Because only a kill threshold is used, the type of weapon which actually killed the target is unknown. Additionally, data may be affected because the SAAB targets can register hits when subject to wind gusts or artillery fire.

The CIS operates on both firing and target (attrition) data based on its time of occurrence. This is the only way actual pairing of firer and target can be accomplished. This system has a potential problem in that closely spaced firings by multiple weapons of the same type may be difficult to differentiate. The problem has an added dimension in live fire in that projectile time-of-flight must be considered in the time correlation. The use of lasers coded with vehicle identification numbers would solve the problem in ES and would also reduce the dependence on accurate time keeping. A solution to the live fire problem is more difficult in that target selection processes must be identified and the weapon type detected by a killed target.

More serious than the pairing problem is the data deficiency which results when a vehicle firing does not achieve a target pairing through time correlation. In this case no data is available on the target of the firing vehicle. This situation can occur for a number of reasons: poor gunnery techniques, false detections, target malfunction, use of direct fire suppression, etc. In any event the ERS will not report any information other than vehicle firing time and weapon type. Perhaps the simplest solution to the problem is the use of a device which measures the azimuth of the main gun at firing and reports this data through ERS. An azimuth device, if accurate to approximately ±3 degrees (50 mils), would give clues to the evaluators as to the reason for non-paired firings. The shortcoming of this solution is that most of the azimuth data would need manual interpretation at the CIS, increasing the evaluation workload. Other definitive solutions, such as the use of a gun camera, would be expensive and require the same manual interpretation.

c. Special Event Recording

The capability of ERS to input to the CIS a total of eight different messages offers a potential for the use of ERS to transmit data other than firing/attrition to the CIS. At present ERS uses three of the eight possible messages [28]. These messages are: firing, hit/near miss, and transmission with the vehicle radio. The other five message slots are available for the transmission of data. One obvious

candidate message is the turret azimuth at firing previously discussed. Other messages might come from combat vehicle crews or from support elements, such as:

(1) <u>Vehicle status</u> (operational or non-operational) - used by all vehicles to indicate breakdowns, thrown tracks, etc.

(2) <u>Cargo status</u> (0-100 percent) - used to trace battalion support activity for ammunition trucks and fuel tankers or fuel status on individual vehicles.

(3) <u>Tow status</u> (yes or no) - used to indicate when a VTR is moving a vehicle casualty.

(4) <u>Pumping status</u> (yes or no) - used to determine re-fueling time for fuel tankers.

(5) <u>Overwatch status</u> (yes or no) - keeps track of the use of overwatch tactics by maneuver units.

(6) <u>Detection message</u> (vehicle detected) - coupled with an azimuth reading, this message could be used to signal a crew detection in a given direction.

Two considerations which affect the use of ERS to record special events are the equipment capabilities and the need for the input of data by training units. In order to minimize the burden on training crews and preserve the quality of the data, there must be a minimum of outside requirements placed on the crews, a fail-safe input scheme, and little opportunity to foil and system by entering false information. Ideally then, all inputs should be automatically

made without crew interaction. This requirement impacts on equipment design. Input or interface boxes connecting the vehicle systems to ERS must be inconspicuous and reliable, and efficient use must be made of the message capabilities of ERS.

d. Indirect Fire Casualty Assessment

The indirect fire data inputs listed in Appendix I are elements of conceptual system for indirect fire assessment at NTC. The actual firing unit inputs to the CIS may be somewhat different, but they will convey the same information - unit firing data which must be transformed to grid locations for round impact and subsequent casualty assessment. The assessment technique is technologically feasible, as proved by the use of IFCAS (Indirect Fire Casualty Assessment System) developed by CDEC, and can provide statistically acceptable casualty assessment for unit evaluation. The present indirect fire data elements and battery information provide an adequate stream of information on which to base unit evaluation. The biggest problem to the EMC personnel in the CIS will be the playing of artillery fire in real time. The use of real time assessment and realistic firing mission procedures will enhance both realism and the evaluation of unit effectiveness. The issue of realistic fire mission procedures and fire effects is primarily a technical one. Since one of the battalion's chief support assets is its direct support artillery, efficient indirect fire evaluation is a key issue.

Battery operations must be assessed in real time. This assessment requires efficient simulation of projectile flight paths based on battery firing data and the ability to put simulated artillery rounds at proper locations for FO adjustment. This training realism for artillery in engagement simulation is a problem which has not yet been solved. In all likelihood a compromise situation will be accepted. In live fire the realism problem is less difficult. Actual marking rounds from a firing battery will require FO adjustment. After adjustment the computer simulation will assess casualties in the fire for effect phase of the artillery mission.

## B. THE EVALUATION SYSTEM

The previous discussion of a conceptual "theory of combat" provides a convenient basis for an analysis of the role of instrumented data in the evaluation plan developed for use at the NTC. The evaluation process, as described in Section IV, uses a top-down analysis methodology to develop general measures of performance which describe unit proficiency. The limiting assumptions, as well as the advantages, of this method have been noted. It is useful, however, to take the instrumented measures of performance developed in Reference 18 and restructure them into a format which is derived from the conceptual theory of combat, also discussed in Section IV. In this format the generalized MOP are classified as either combat inputs, processes, or outcomes (IPO) in accordance with

the systems view of combat. As previously discussed, performance measures from each of the IPO categories will be needed for the assessment of combat battalions at NTC, and this analysis will enable a closer examination of the performance measures to see if the evaluation spectrum required at NTC is covered. The ability of instrumentation to cover a large part of the evaluation process is a key question. If this is possible, it will release field controllers to cover other areas in the evaluation and the use of computers will speed computation of essential performance statistics.

The restructured performance measures are presented in Appendix J. In the analysis of the present performance measures, it was decided to change as little as possible from the structure of Reference 18. Accordingly, all EEA and MOE were retained in their original form, regardless of applicability. MOP were classified as inputs, processes, or outcomes and grouped under their respective MOE/MOP. In many cases MOP were repetitive across various MOE and EEA. When this occurred the repetitious MOP were not listed, unless the analysis placed subsequent MOP in a different IPO category. The unit level at which the MOP are evaluated is preserved from Reference 18. The structuring of MOP into IPO cateogries is merely one step beyond the approach used in Reference 18. Admittedly, it does apply a concept which was not used in the original formulation of MOP. Therefore, many MOP were placed in an IPO category strictly through the judgment of the researcher. In some cases a minor change in the wording

of a performance measure or a different interpretation would change the category selection. Thus, the IPO analysis is a subjective process which yields only general conclusions. Nevertheless, it does provide a basis for examination of the evaluation process and the role of instrumented data inputs.

Of the 291 performance measures examined, 22 were classified as combat inputs. The EEA structure proves to be cumbersome, and a hindrance to effective formulation and classification in this case. Reference 10, in its discussion of combat inputs, classifies the EEA into six basic categories:

mission,

human characteristics and behavior,

material resources (weapons, vehicles),

organization and structure,

tactics, and

the operating environment.

The use of EEA similar to those above would make input analysis easier. As done presently, each of the eight EEA would require subcomponents composed of a few or all of the six areas listed above. However, the eight original EEA are effective descriptive elements for the combat processes and outcomes categories. These two categories contain over 90 percent of the listed MOP.

Slightly more than 20 percent of the instrumented MOP could be classified as combat processes. This number is again subject to the interpretation, depending on the particular bias of the analyst. The eight EEA originally used approximate the

accepted subprocesses of combat and provide a good start point for a breakdown into MOE/MOP. However, an examination of the MOP in the process section reveals that over half of the MOP (37 of 71) require a yes/no response rather than the computation of a statistic. This situation is not unusual, nor is it a real problem. The process category is the "why" and "how" part of the combat system. In the combat processes the reasons for an action are determined and the relationships between input and output processes are specified. Of the three IPO categories, it is the least understood [10]. As a result, quantitative answers will not be forthcoming in many circumstances. In fact, conversion of these MOP into quantitative measures generally causes them to be moved into the combat outcomes category. The process category does not seem generally suited to the development of instrumented measures. Perhaps software can be developed to generate a few of the yes/no answers, and a tabulation can be made of them, but their applicability and interpretation may not justify the ffort.

The majority of instrumented performance measures were classified as describing the outcomes of the combat processes. Seventy percent of the MOP investigated were related to these outcomes. The reporting of what happened in an exercise can utilize the speed and accuracy advantages of the computer. Combat results are generally quantifiable and do not require interpretation by any intermediate agency. In the combat

outcomes area lies the real opportunity for employment of instrumentation. With a few of the modifications and additions specified in the previous section, areas other than firing/attrition can supply outcome data, leaving field controllers and TAF personnel to interpret the combat inputs and processes.

The advantages of the NTC instrumentation system lie in the combat outcomes part of the IPO process. A few of the input measures, such as material resources and organization, may be optimized for evaluation by instrumentation, but the majority of inputs, as well as combat processes, are best evaluated by manual means.

The IPO analysis can be used to assist in both the development of new performance measures and the evaluation of existing ones. But more important than the IPO analysis is the evaluation of the usefulness of individual MOP. The MOP which are developed must be meaningful and collectable by the available instrumentation hardware. Stevens [12] lists among the characteristics of good MOE/MOP that they be precisely defined in terms meaningful both to analyst and user. In addition, the capability to collect the MOP must exist. To list "How many times did the platoon seek cover and concealment?" as an instrumented MOP is unacceptable without defining "cover and concealment" and specifying how it is to be measured. In this regard a catalogue of collectable data elements, as in Appendix I, is a useful tool for determining if a particular statistic can be generated from instrumented data inputs. The comment on MOE/MOP development applies equally to VRS

and manually collected performance measures, as their usefulness depends on their definition and the capacity of the evaluation system to collect them.

# VI. CONCLUSIONS AND RECOMMENDATIONS

This paper served both as an introduction to the problems and processes at the NTC and as a limited evaluation of the role and usefulness of instrumentation in the evaluation process. The National Training Center was shown to be a complex institution which inserts rotational combat battalions into a total training environment which features realistic training and objective performance feedback. The description of NTC showed it to be a manpower intensive project which requires the support of over 2500 personnel to provide training for a combat battalion of 500-800 men. In addition to the required manpower, the NTC will require an expenditure of over $300 million in initial costs and have a yearly budget of nearly $50 million. The only possible way to justify these costs is to maximize the learning of training battalions while at NTC. This learning is, in large part, a function of the instrumentation system. The NTC instrumentation system was analyzed to examine the functioning of its parts and its role in the evaluation process. In the final analysis the instrumentation was seen to be an important part of evaluation, but only one part of the total process. No matter how complex the instrumentation or how many elements it monitors, it will never be totally satisfactory in evaluating all or even most of the human processes interacting in training at the NTC. The chief advantage of instrumentation is its ability

to rapidly assess the combat outcomes which can be measured. This step alone marks a significant advance in training technology because it allows mock combat to be the teacher and uses actual outcomes as an indicator of a unit's grade. However, the evaluation system for NTC must identify reasons for a particular behavior, so that remedial training can be prescribed. The analysis which evaluates behavior lies generally outside the purview of instrumentation and it must usually be judged by observers in a somewhat subjective manner.

The NTC system is a complex one, and this paper has supplied only an introduction to the entire process. Other significant areas await investigation. These other areas can best be divided into three functional parts: the other operating roles of NTC, the NTC evaluation process, and NTC management process.

This paper addressed NTC only as it trains the battalion task force. NTC will conceptually provide training for brigade headquarters and staff elements and will also operate a command post exercise (CPX) for rotating battalion staffs which operate in conjunction with field task force training. The CPX will use CATTS (Combined Arms Tactical Training Simulator) as the exercise agency for the national battalions. Development work in this area will require much of the same analysis work as for the battalion evaluation. This involves an operating concept, mission statements, a proposed command structure, scheduling considerations, and an interface with

field battalion training at NTC. Attempts to link CPXs with field maneuvers have proven extremely difficult to accomplish in the past. It remains to be seen whether this can be done at NTC.

The evaluation process, examined in this paper for instrumented inputs, has analysis opportunities in a variety of areas. Development of additional MOE/MOP, analysis of VRS and manual data, and the formulation of a good analysis/collection plan for all data elements must be done. Additionally, a good method for presenting training feedback to the maneuver units must be developed. This method must determine who to debrief, with what materials, and where and how the debriefing will be conducted.

The last area of consideration deals with the management of training assets at Fort Irwin. The NTC is complicated process with a large budget and significant operating problems. Optimum rotation of units, effective supply forecasting, and the optimization of support requirements are routine problems with which the NTC commander must deal. Because of its isolation and unique training responsibilities, the NTC is a relatively closed system. The NTC began as a bare ground operation which required most assets to be moved in to begin operations. When in full operation, it will have very specified interactions with off post agencies. This situation offers unique opportunities to analyze flows and processes in a relatively straightforward context.

Within each of the three previously discussed areas there exist many opportunities for useful and concrete analysis. The NTC is an evolving system which is still formulating its operating methods and techniques. The use of good analysis can prevent costly errors and optimize operating policies before the institutional roadblocks which prevent change come into existence.

# APPENDIX A

## RESEARCH CHRONOLOGY

| Date | Activity/Agency |
|---|---|
| May 1979 | Contact with TRADOC NTC System Manager (TSM): COL Edwards |
| July-September 1979 | Contact with NTC Office at CATRADA (Fort Leavenworth) |
| October 1979 | Outline of possible work efforts with TSM at Fort Monroe |
| November 1979 - January 1980 | Liaison and research efforts conducted with the aid of the following agencies: |
| | Science Applications, Inc. (SAI) (Mr. Fern, Dr. Hansen) |
| | Ford Aerospace Communications Corporation (Mr. Glusovitch) |
| | CATRADA (MAJ Kauffman) |
| | CDEC (CPT Williams, Mr. Batesole, Dr. Marke) |
| | U.S. Army Field Artillery School (CPT Butler) |
| | U.S. Army Research Institute (Monterey) (Dr. Banks, MAJ Loftis) |
| | NTC TRADOC Systems Manager Office (MAJ Fitzgerald, MAJ Graney) |
| | TCATA Training Directorate (Mr. Melton) |
| February 1980 | Validation of information |

## APPENDIX B

## SAMPLE BATTALION SCHEDULE

| Day | Activity |
|---|---|
| **A. Predeployment** | |
| -180 days | Unit Alerted<br>Tentative mission selection |
| -90 days | Unit ARTEP<br>CATTS and MILES training |
| -30 days | Missions for NTC confirmed<br>Zero individual weapons |
| -10 days | Advanced party departs |
| **B. Deployment** | |
| -10 days | Advance party closes Fort Irwin<br>Establish receiving party |
| -3 days | Main body closes FT Irwin<br>Draw POMCUS stock |
| -1 day | Unit maintenance<br>Receive NTC briefing<br>Receive Mission 1 |
| **C. Tactical Training** | |
| Day 1-3 | Mission 1 |
| Day 3-4 | After action review<br>Maintenance/recovery<br>Receive Mission 2 |
| Day 4-6 | Mission 2 |
| Day 6 | After action review<br>Maintenance/recovery<br>Receive Mission 3 |
| Day 7-8 | Mission 3 |
| Day 8 | After action review<br>Maintenance/recovery<br>Receive Mission 4 |

| Day | Activity |
|---|---|
| Day 9-10 | Mission 4 |
| Day 10 | After action review<br>Maintenance/recovery<br>Receive Mission 5 |
| Day 10-12 | Mission 5 |
| Day 12-13 | After action review<br>Maintenance/recovery<br>Preparation for Mission 6 (Live fire) |
| Day 13-14 | Mission 6 (Live fire exercise) |
| Day 14 | After action review<br>Final critique<br>Delivery of take home package |

D. Redeployment

| | |
|---|---|
| +15 days | Maintenance |
| +16 days | Unit begins POMCUS turn-in |
| +17 days | Main body redeploys |
| +20 days | Turn-in complete<br>Trail party redeploys |

## APPENDIX C

## TACTICAL MISSIONS AT THE NTC

| Mission | Live Fire | Engagement Simulation |
|---|---|---|
| Movement to contact | X | X |
| Hasty attack | X | X |
| Defend in sector | X | X |
| Delay | | X |
| Deliberate attack | X | X |
| Conduct passage of lines | | X |
| Counterattack by fire from a battle position | X | X |
| Defend a battle position | X | X |
| Defend from a battle area | X | X |
| Overwatch from a battle position | X | X |
| Defend to retain a battle position | X | X |
| Relief operations | | X |
| Defend a strong point | X | X |
| River crossing | | X |
| Withdrawal | | X |
| Breakout from encirclement | | X |
| Link up | | X |
| Zone, area and route reconnaissance | X | X |
| Security missions (screen and guard) | | X |
| Raid | | X |
| Reconnaissance in force | | X |

APPENDIX D

PL/ERS PLAYER UNITS FOR NTC

| Type | Number of Units |
| --- | --- |
| Ground Vehicles | 315 |
| Air Defense Systems | 20 |
| Helicopters | 30 |
| Airborne Forward Air Controllers | 5 |
| High Performance Aircraft | 20 |
| Manpacks, other | 110 |
| Total Units | 500 |

# APPENDIX E

## MILES RANGE AND AMMUNITION PARAMETERS

| Weapon | Basic Load (Silent Fire) | Burst Limit | Range of Simulator Kill | Near Miss |
|---|---|---|---|---|
| M16A1 | 210 | 30 | 5-460 | 5-460 |
| M60 MG | 600 | 30 | 5-800 | 5-1100 |
| M85/M2 MG | 1200 | 30 | 5-800 | 5-1600 |
| 105 MM Gun | 63 | - | 50-3000 | 50-3000 |
| TOW | 10 | - | 50-3000 | 50-3000 |
| Dragon | 4 | - | 50-1000 | 50-1000 |

## APPENDIX F

### PROGRAMMED MILES EQUIPMENT FOR NTC

| Type | Number |
|---|---|
| Man worn detector sets | 1664 |
| M16 transmitters | 1039 |
| M60 LMG transmitters | 134 |
| VIPER/LAW transmitters | 134 |
| Dragon MAW transmitters | 65 |
| TOW HAW transmitters | 48 |
| M113 Vehicle set | 157 |
| M60A1 tank set | 124 |
| M151 jeep set | 37 |
| M551 OPFOR Vehicle set | 230 |

MILES KILL PROBABILITIES

| Weapon | # Hit Words Per Round | P(Kill) per round Truck/Jeep | AC/Helo | APC | Tank |
|---|---|---|---|---|---|
| Maverick | 8 | 1.0 | 1.0 | 1.0 | 1.0 |
| Hellfire | M | 1.0 | 1.0 | 1.0 | .937 |
| Sagger | M | 1.0 | .953 | .984 | .703 |
| TOW/Shillelagh | M | 1.0 | .984 | 1.0 | .859 |
| Dragon | M | 1.0 | 1.0 | .984 | .765 |
| 105 mm Tank Gun | 8 | .968 | 1.0 | .968 | .875 |
| 2.75in FFAR | 8 | .968 | .921 | .781 | .421 |
| VIPER | 8 | .968 | .921 | .812 | .483 |
| BUSHMASTER (25mm), GAU-8 (30 mm) | 2 | .843 | .437 | .093 | .062 |
| ZSU 23-4 | 2 | .437 | .500 | .062 | NO EFFECT |
| VULCAN (20mm) | 2 | .437 | .234 | .062 | NO EFFECT |
| M2, M85 (50 cal) MG | 4 | .375 | .046 | .046 | NO EFFECT |
| CHAPARRAL | 8 | NO EFFECT | .968 | NO EFFECT | NO EFFECT |
| STINGER (REDEYE) | 8 | NO EFFECT | .921 | NO EFFECT | NO EFFECT |
| M16, M60, M240 | 4 | .093 | .031 | NO EFFECT | NO EFFECT |

M = missile

## APPENDIX H

## DISTIRBUTION OF INSTRUMENTED EQUIPMENT

A. Tank Battalion

B. Mechanized Infantry Battalion

C. Support Equipment

D. OPFOR Motorized Rifle Regiment

E. Controller Equipment

F. Recapitulation of Instrumented Systems

PL - position location equipment

ERS - event recording system and MILES receiver, no MILES transmitter connected to ERS

MILES/ERS - complete MILES system interfaced with event recording system

MILES - complete MILES system in stand alone operation, no connection to event recording system

WSI/ERS - weapon system interface with connection to event recording system

CIS - capability to input indirect fire data to CIS for IF assessment

| | PL | ERS | MILES/ERS | MILES | WSI/ERS | CSI |
|---|---|---|---|---|---|---|
| A. Tank Battalion (TOE 17-35 H) | | | | | | |
| 1. Headquarters and Headquarters Company | | | | | | |
| a. HQs Tank Section | | | | | | |
| M60A1 Tank (3) | x | x | | | | |
| 105 mm Gun | | | x | | x | |
| .50 Cal MG | | | | x | | |
| 7.62 mm MG | | | | x | | |
| b. Battalion HQs | | | | | | |
| M577 Command Post Vehicle (1) | x | x | | | | |
| M113 Armored Personnel Carrier (1) | x | x | | | | |
| .50 cal MG | | | | x | | |
| M151 1/4-Ton Truck (3) | | | | | | |
| Manpack (1) | x | x | | | | |
| c. Support Platoon, Maintenance Platoon | | | | | | |
| 5-ton Truck | | | | | | |
| .50 cal MG | | | | x | | |
| M88 VTR | | | | | | |
| .50 cal MG | | | | x | | |
| M578 Wrecker | | | | | | |
| .50 cal MG | | | | x | | |
| Goer and Goer Wrecker | | | | | | |
| 2. Tank Company (3) | | | | | | |
| a. M60A1 Tank (17) | x | x | | | | |
| 105 mm Gun | | | x | | x | |
| .50 cal MG | | | | x | | |
| 7.62 MG | | | | x | | |
| b. Company Headquarters | | | | | | |
| 2 1/2-Ton Truck (2) | | | | | | |
| .50 cal MG | | | | x | | |

| | PL | ERS | MILES/ERS | MILES | WSI/ERS | CIS |
|---|---|---|---|---|---|---|
| M88 VTR | | | | | | |
| .50 cal MG | | | | x | | |
| 1/4-Ton Truck (3) | | | | | | |
| Manpack (1) | x | x | | | | |
| 3. Combat Support Company | | | | | | |
| a. M113A1 (1) (CO vehicle) | x | x | | | | |
| .50 cal M2 | | | | x | | |
| b. Armored Vehicle Launched Bridge (2) | | | | | | |
| c. Ground Surveillance Section (4) | | | | | | |
| M151 1/4-Ton Truck | x | x | | | | |
| d. Maintenance/Supply Section | | | | | | |
| M578 VTR | | | | | | |
| .50 cal MG | | | | x | | |
| 2 1/2-Ton Truck (2) | | | | | | |
| .50 cal MG | | | | x | | |
| e. Battalion Scout Platoon | | | | | | |
| M113 Armored Personnel Carrier (2) | x | x | | | | |
| .50 cal MG | | | | x | | |
| M113 Armored Personnel Carrier (4) | x | x | | | | |
| .50 cal MG | | | | x | | |
| TOW (mounted and dismounted) | x | | x | | | |
| M113 Armored Personnel Carrier (4) | x | x | | | | |
| .50 cal MG | | | | x | | |
| Dragon | | | | x | | |

| | PL | ERS | MILES/ERS | MILES | WSI/ERS | CIS |
|---|---|---|---|---|---|---|
| f. Battalion Heavy Mortar Platoon | | | | | | |
| M577 Command Post Carrier (FDC) | x | x | | | | x |
| M106 Mortar Carrier | | | | | | |
| .50 cal MG | | | | x | | |
| g. Redeye Section | | | | | | |
| M151 1/4-Ton Truck (5) | x | x | | | | |
| Redeye/Stinger | | | | x | | |
| 4. Miscellaneous Battalion Weapons | | | | | | |
| M16/M203 | | | | x | | |
| VIPER/LAW | | | | x | | |
| M60 MG | | | | x | | |
| B. Mechanized Infantry Battalion (TOE 7-45H) | | | | | | |
| 1. Headquarters and Headquarters Co. | | | | | | |
| a. Battalion HQs | | | | | | |
| M151 1/4-Ton Truck (1) | x | x | | | | |
| M577 Command Post Carrier (3) | x | x | | | | |
| M113 Armored Personnel Carrier (1) | x | x | | | | |
| .50 cal MG | | | | x | | |
| Manpack (1) | x | x | | | | |
| b. Support Platoon, Maintenance Platoon | | | | | | |
| M578 VTR (2) | | | | | | |
| .50 cal MG | | | | x | | |
| 2 1/2-Ton, 5-Ton Trucks | | | | | | |
| .50 cal MG | | | | x | | |
| 2. Mechanized Infantry Company (3) | | | | | | |
| a. Headquarters Platoon | | | | | | |
| M113 Armored Personnel Carrier (1) | x | x | | | | |
| .50 cal MG | | | | x | | |

| | PL | ERS | MILES/ERS | MILES | WSI/ERS | CIS |
|---|---|---|---|---|---|---|
| M578 VTR | | | | | | |
| .50 cal MG | | | | x | | |
| 2 1/2-Ton Trucks (2) | | | | | | |
| .50 cal MG | | | | x | | |
| Manpack | x | x | | | | |
| b. Rifle Platoons (3) | | | | | | |
| M113 Armored Personnel Carrier (4) | x | x | | | | |
| .50 cal MG (4) | | | | x | | |
| Dragon (3) | | | | x | | |
| 7.62 mm MG | | | | x | | |
| c. Weapons Platoon | | | | | | |
| M113 Armored Personnel Carrier (FDC) | x | x | | | | x |
| .50 cal MG | | | | x | | |
| M125 Mortar Carrier (3) | | | | | | |
| .50 cal MG | | | | x | | |
| M113 Armored Personnel Carrier (2) | x | x | | | | |
| .50 cal MG | | | | x | | |
| TOW (mounted or dismounted) | x | | x | | | |
| 3. Combat Support Company | | | | | | |
| a. Headquarters Platoon | | | | | | |
| M113A1 Armored Personnel Carrier (1) | x | x | | | | |
| .50 cal MG | | | | x | | |
| Maintenance/Supply Section | | | | | | |
| M578 VTR | | | | | | |
| .50 cal MG | | | | x | | |
| 2 1/2-Ton Truck (2) | | | | | | |
| .50 cal MG | | | | x | | |

| | PL | ERS | MILES/ERS | MILES | WSI/ERS | CIS |
|---|---|---|---|---|---|---|
| b. Ground Surveillance Section | | | | | | |
| M151 1/2-Ton Truck (4) | x | x | | | | |
| c. Battalion Scout Platoon | | | | | | |
| M113 Armored Personnel Carrier (2) | x | x | | | | |
| .50 cal MG | | | | x | | |
| M113 Armored Personnel Carrier (4) | x | x | | | | |
| .50 cal MG | | | | x | | |
| TOW | x | | x | | | |
| M113 Armored Personnel Carrier (4) | x | x | | | | |
| .50 cal MG | | | | x | | |
| Dragon | | | | x | | |
| d. Battalion Heavy Mortar Platoon | | | | | | |
| M577 Command Post Carrier (FDC) | x | x | | | | x |
| M106 Mortar Carrier | | | | | | |
| .50 cal MG | | | | x | | |
| e. Redeye Section | | | | | | |
| M151 1/4-Ton Truck (5) | x | x | | | | |
| Redeye/Stinger | | | | x | | |
| f. Battalion Anti-Tank Platoon | | | | | | |
| M113 APC (HQ's) | | | | | | |
| .50 cal MG | | | | x | | |
| M113 APC (12) | x | x | | | | |
| .50 cal MG | | | | x | | |
| TOW | x | | x | | | |
| g. Miscellaneous Battalion Weapons | | | | | | |
| M16/M203 | | | | x | | |
| M60 MG | | | | x | | |
| VIPER/LAW | | | | x | | |

| | PL | ERS | MILES/ERS | MILES | WSI/ERS | CIS |
|---|---|---|---|---|---|---|
| C. Battalion External Support | | | | | | |
| 1. Army Air | | | | | | |
| Attack Helicopter | x | x | | | | |
| 20 mm Cannon | | | | x | | |
| TOW | | | x | | | |
| 7.62 Minigun/Grenade Launcher | | | | x | | |
| 2.75 FFAR | | | | x | | |
| Scout Helicopter | x | x | | | | |
| 2. Air Force Close Air Support | | | | | | |
| OV-10 Bronco (FAC) | x | x | | | | |
| A-10 Thunderbolt II (or other CAS aircraft) | x | x | | | | |
| GAU-8 | | | | x | | |
| Maverick | | | x | | | |
| 3. Engineer Company (-) | | | | | | |
| M113 APC (squad Vehicle) (3) | x | x | | | | |
| .50 cal MG | | | | x | | |
| 4. FA Direct Support Battery | | | | | | |
| M577 CP Carrier (FDC) | x | x | | | | x |
| M109 Howitzer | | | | | | |
| .50 cal MG | | | | x | | |
| FIST (includes FO's for Bn Mortar Platoons) | | | | | | |
| M113 APC | x | x | | | | |
| .50 cal MG | | | | x | | |
| 5. ADA Support | | | | | | |
| M113 APC (Vulcan Gun Carrier) (8) | x | x | | | | |
| 20 mm Vulcan AD Gun | | | | x | | |

| | PL | ERS | MILES/ERS | MILES | WSI/ERS | CIS |
|---|---|---|---|---|---|---|
| D. OPFOR Unit (Motorized Rifle Regiment) (All vehicles are modified M551 AR/AAV) | | | | | | |
| 1. Regimental Assets | | | | | | |
| a. Headquarters | | | | | | |
| Command and Control Vehicles (6) | x | x | | | | |
| b. Recon Company | | | | | | |
| PT-76 Light Tank (3) | x | x | | | | |
| 76 mm Gun | | | x | | | |
| Coax MG | | | | x | | |
| BRDM APC (9) | x | x | | | | |
| c. Anti-aircraft Battery | | | | | | |
| ZSU-23-4 (4) | x | x | | x | | |
| SA-9 (4) | x | x | | x | | |
| d. ATGM Battery | | | | | | |
| ATGM Vehicle AT-2/3 (9) | x | x | | | | |
| Sagger missile | | | x | | | |
| 2. Tank Battalion | | | | | | |
| T-62/T-72 Tank (40) | x | x | | | | |
| Main gun | | | x | | | |
| Coax MG | | | | x | | |
| 12.7 mm AA MG | | | | x | | |
| 3. Motorized Rifle Battalions (3) (aggregated equipment) | | | | | | |
| APC BMP (90) | x | x | | | | |
| 73 mm Gun | | | | x | | |
| Sagger missile | | | x | | | |
| APC BTR/BRDM (6) | x | x | | | | |
| 120 mm Mortar (18) | | | | | | |
| SA-7 Grail (27) | | | | x | | |
| SPG-9 Recoilless | | | | x | | |
| PKM LMG | | | | x | | |

| | PL | ERS | MILES/ERS | MILES | WSI/ERS | CIS |
|---|---|---|---|---|---|---|
| 4. Reinforcing Tank Battalion (-) | | | | | | |
| T-62/T-72 Tank (15) | x | x | | | | |
| Main Gun | | | x | | | |
| Coax MG | | | | x | | |
| 12.7 mm AA MG | | | | x | | |
| E. Controller Equipment | | | | | | |
| Battalion Controllers (18) | x | | | | | |
| MILES Controller Gun | | | | x | | |
| Fire Markers | x | | | | | |
| Video camera crews | x | | | | | |

F. Recapitulation of Instrumented Weapons
NOTE: Organic weapons only. Task force organization (single battalion) is used

| | Tank-Heavy TF | Mech-Heavy TF | OPFOR(MRR) |
|---|---|---|---|
| 1. Engagement Simulation | | | |
| a. Number of Vehicles with PL/ERS | 74 | 85 | 180 |
| b. Major Weapons Systems with MILES/ERS (tank gun, TOW, Sagger) | 43 | 37 | 163 |
| c. Major Weapons Systems with MILES only (Dragon, 73 mm (BMP), Sagger) | 13 | 22 | 96 |
| d. Total number of Major Weapons Systems | 56 | 59 | 259 |
| 2. Live Fire | | | |
| a. Number of Weapons Systems with WSI/ERS used for live fire | 37 | 17 | - |
| b. Number of Weapons Systems with MILES/ERS used for live fire (TOW) | 6 | 20 | - |
| c. Total number of ERS-instrumented weapons | 43 | 37 | |
| d. Number of Weapons Systems with MILES only and used for live fire (Dragon) | 13 | 22 | - |
| e. Total number of major weapons systems for live fire (Tank, TOW, Dragon) | 56 | 59 | - |

APPENDIX I

## INSTRUMENTED DATA ELEMENTS

A. Engagement Simulation

| | Data Element | Source |
|---|---|---|
| 1. | Vehicle location, updated every 4-10 secs | PLS |
| 2. | Time Vehicle radio transmitter keyed | ERS |
| 3. | Time of weapon firing | MILES/ERS |
| | Type of weapon firing (MWS only) | MILES/ERS |
| 4. | Time of near miss received on vehicle | MILES/ERS |
| | Type of weapon which fired near miss at time t | MILES/ERS |
| 5. | Time of vehicle kill | MILES/ERS |
| | Type of weapon which killed vehicle at time t | MILES/ERS |
| 6. | Time of weapon firing for indirect fire | firing unit to CIS |
| | Firing data for IF mission | firing unit to CIS |
| | Type of indirect fire | firing unit to CIS |
| | Number of rounds of indirect fire | firing unit to CIS |
| 7. | Location and burst pattern of IF | CIS |
| | Vehicles killed by indirect fire | CIS/PLS |
| | Vehicles receiving near miss by indirect fire | CIS/PLS |
| | Time of IF impact | CIS |
| | Location of IF unit | PLS |
| 8. | Digitized terrain data (DMA) | CIS |
| 9. | Unit graphic control measures | CIS |

B. Live fire

| | Data Element | Source |
|---|---|---|
| 1. | Location of target | Range data (known) |
| | Type of target | Range data |
| | Kill threshold of target | Range data |
| 2. | Time target was exposed to maneuver unit | microcomputer-target control (M/TCU) to CIS |
| | Time firing cue (flash) was presented to unit | M/TCU to CIS |
| 3. | Time target was removed from unit view | M/TCU to CIS |
| 4. | Time of target kill | M/TCU to CIS |
| | Time of target hit (other than kill) | M/TCU to CIS |
| | Type of weapon which killed target (ballistic or MILES-laser) | M/TCU to CIS |
| 5. | Location of Vehicle, updated every 4-10 seconds | PLS |
| 6. | Time of weapon firing (MWS only) | WSI/ERS |
| | Type of weapon (MWS only) | WSI/ERS |
| 7. | Time of fire for IF | firing unit to CIS |
| | Firing data for IF mission | firing unit to CIS |
| | Type of IF | firing unit to CIS |
| | Number of rounds fired | firing unit to CIS |
| 8. | Location and burst pattern of IF | CIS |
| | Vehicles killed by IF | CIS/PLS |
| | Vehicles receiving near miss by IF | CIS/PLS |
| | Time of IF impact | CIS |
| | Location of IF unit | PLS |

## APPENDIX J

## RESTRUCTURED MOE/MOP TABLE FOR INSTRUMENTED DATA

The attached table represents MOE/MOP elements from Reference 18 which are restructured to put them in three categories:

Combat Inputs

Combat Processes

Combat Outcomes

The original EEA and MOE are preserved, only the MOP are restructured. In many cases in the table, MOP were duplicated in different MOE. However, each MOP is listed only where it first occurred, and duplicated only if its category changed in subsequent listings. Unit level abbreviations are:

B - battlaion

C - company

P - platoon

## A. COMBAT INPUTS

| | | | Unit Level | Ref Page |
|---|---|---|---|---|
| **1. <u>EEA: Maneuver</u>** | | | | |
| a. | MOE: | Force ratio - beginning | | |
| | MOP: | How much equipment is available by type? | C-P | A-1 |
| | | How many HAWS were available? | B-C-P | A-1 |
| | | What percent of OPFOR forces engaged in the initial contact? | B C P | A-1 |
| | | How many Tanks were located within designated positions? | C P | A-2 |
| | | How many TOWS were located within designated positions? | C P | A-2 |
| | | How many vehicles were available? | B C P | A-2 |
| | | How many troops were available? | B C P | A-2 |
| | | Was Dragon position occupied? | B C P | A-2 |
| | | How many weapons/weapon systems were available? | B C P | A-3 |
| | | What combat power was available? | B C P | A-4 |
| b. | MOP: | Force ratio - end<br>MOP: none | | |
| c. | MOP: | Number of hits per number of firings by major weapons system (mws)<br>MOP: none | | |
| d. | MOP: | Actual detection (time-distance)<br>MOP: none | | |

| | | | Unit Level | Ref Page |
|---|---|---|---|---|
| e. | MOE: | Percentage of enemy losses inflicted (direct fire) by mws | | |
| | MOP: | How many targets were in area of responsibility? | P | A-11 |
| f. | MOE: | Percentage of enemy losses inflicted by (direct fire) maneuver and unit<br>MOP: none | | |
| g. | MOE: | Planned vs actual (distance-time) engagement | | |
| | MOP: | What was the range of first planned engagements? | B C | A-15 |
| h. | MOE: | Number of OPFOR destroyed (function of range)<br>MOP: none | | |
| i. | MOE: | Planned vs actual:<br>a) unit maneuver (include CPs, trains)<br>b) disengagement<br>MOP: none | | |
| j. | MOE: | Firing time (by mws) from ID to engage<br>MOP: none | | |
| k. | MOE: | Rate of Blue movement<br>MOP: None | | |

| | | | Unit Level | Ref Page |
|---|---|---|---|---|
| 2. | EEA: Fire Support | | | |
| a. | MOE: | Response time for indirect fire requirements (call for fire to fire for effect) | | |
| | MOP: | How many registrations were conducted? | B | A-29 |
| | | How many registrations were to the rear? | B | A-29 |
| | | What was the number of offset registrations? | B | A-29 |
| b. | MOE: | Number of sorties allocated vs sorties utilized<br>MOP: none | | |
| c. | MOE: | Number of sorties flown vs aircraft lost<br>MOP: none | | |
| d. | MOE: | Number of OPFOR assets lost by weapons system (T-64, BMP, people, etc.) to close air support<br>MOP: none | | |
| e. | MOE: | Range at which OPFOR deployed | | |
| | MOP: | What was the range of first planned engagement? | B C P | A-35 |
| f. | MOE: | Percent of Fire Missions fired | | |
| | MOP: | How much artillery ammunition was available? | B | A-38 |
| g. | MOE: | Response time for indirect fire requirements<br>MOP: none | | |

| | | | Unit Level | Ref Page |
|---|---|---|---|---|
| h. | MOE: | Number of suppression missions fired vs number of weapons systems suppressed | | |
| | MOP: | none | | |

3. EEA: Mobility/Counter-mobility

| | | | Unit Level | Ref Page |
|---|---|---|---|---|
| a. | MOE: | Time for OPFOR to break obstacles | | |
| | MOP: | How many weapons/weapon systems were available? | B C P | A-43 |
| b. | MOE: | Number of OPFOR losses during breach | | |
| | MOP: | none | | |
| c. | MOE: | Time to breach obstacles (for US) | | |
| | MOP: | none | | |
| d. | MOE: | Number of Blue losses during breach | | |
| | MOP: | none | | |
| e. | MOE: | Number (percent) of obstacles encountered by OPFOR | | |
| | MOP: | none | | |
| f. | MOE: | Rate of OPFOR movement | | |
| | MOP: | none | | |
| g. | MOE: | Number/percent of engineer assets lost | | |
| | MOP: | How many weapons/weapon systems were available? | B C P | A-51 |
| h. | MOE: | Number planned vs emplaced/completed engineer tasks | | |
| | MOP: | none | | |

| | | | Unit Level | Ref Page |
|---|---|---|---|---|
| i. | MOE: | Percent of engineer/ equipment hours utilized per number of availability | | |
| | MOP: | How many vehicles were available? | B C P | A-54 |
| | | How much equipment is available, by type? | B C | A-55 |
| j. | MOE: | Percentage of hit vs engagement as a function of: weapon, exposure, degree of exposure<br>MOP: none | | |

4. <u>EEA: Air Defense</u>

| | | | Unit Level | Ref Page |
|---|---|---|---|---|
| a. | MOE: | Number of hostile aircraft that attacked Blue forces<br>MOP: none | | |
| b. | MOE: | Number of casualties due to enemy air<br>MOP: none | | |
| c. | MOE: | Percent killed by weapons system<br>MOP: none | | |
| d. | MOE: | Percentage of hostiles engaged that were killed<br>MOP: none | | |
| e. | MOE: | Percentage of engageables that were engaged per weapons system<br>MOP: none | | |
| f. | MOE: | Percentage of attackers who were engageable | | |
| | MOP: | How many air targets were available for engagement? | B | A-65 |

| | | Unit Level | Ref Page |
|---|---|---|---|
| 5. | EEA: Combat Service Support | | |
| a. | MOE: Number of mws out of action for maintenance/number of mws assigned<br>MOP: none | | |
| b. | MOE: Number of other major systems out of action for maintenance/number of such systems assigned<br>MOP: none | | |
| c. | MOE: Time to repair returned systems<br>MOP: none | | |
| d. | MOE: Number of major weapons systems out of action/number of major systems returned to action<br>MOP: none | | |
| e. | MOE: Number of other major systems out of action/number of other systems returned to action<br>MOP: none | | |
| f. | MOE: Number of major systems where maintenance was resolved | | |
| g. | MOE: Number of organizationally repairable equipment. Subset: out of action for maintenance/number of pieces of such equipment assigned | | |
| | MOP: How many weapons are functional, by type? | B | A-72 |
| h. | MOE: Maintenance support request/answered<br>MOP: none | | |

| | | Unit Level | Ref Page |
|---|---|---|---|
| i. | MOE: Number of major weapons systems over time out of action due to lack of supply of:<br>MOP: none | | |
| j. | MOE: Effectiveness of CSS in fields other than maintenance and supply<br>MOP: none | | |

6. EEA: NBC

| | | | |
|---|---|---|---|
| a. | MOE: Number of casualties from NBC vs number exposed<br>MOP: none | | |
| b. | MOE: Manhours/equipment directed from primary mission<br>MOP: none | | |
| c. | MOE: Manhours/equipment diverted from primary mission<br>a) initial<br>b) residual<br>MOP: none | | |

7. EEA: Command and Control, Communications ($C^3$)

| | | | |
|---|---|---|---|
| a. | MOE: Number of messages attempted vs number of transmission acknowledged<br>MOP: none | | |
| b. | MOE: Lapsed time of transmission (decision time from receipt of info until passed on)<br>MOP: none | | |

| | | | Unit Level | Ref Page |
|---|---|---|---|---|
| c. | MOE: | Time from information in to action out | | |
| | MOP: | none | | |
| d. | MOE: | Number of EEFI exposed to OPFOR compromised<br>a) ELINT<br>b) COMSEC<br>c) SIGSEC<br>d) Counter Surveillance<br>e) etc. | | |
| | MOP: | none | | |
| e. | MOE: | Total top to action and/ or bottom to action time | | |
| | MOP: | none | | |
| f. | MOE: | Time from immediate request to execution | | |
| | MOP: | none | | |

8. <u>EEA: Intelligence/Counter Intelligence</u>

| | | | Unit Level | Ref Page |
|---|---|---|---|---|
| a. | MOE: | EEFI compromised | | |
| | MOP: | What was the number of STANO devices functional? | B | A-150 |
| b. | MOE: | Number of OPFOR detectable/number of OPFOR detected (by time and location). (Detected includes reported) | | |
| | MOP: | none | | |
| c. | MOE: | Number of total OPFOR accurately described in terms of location, composition, and intention/ number of total OPFOR | | |
| | MOP: | none | | |

B. COMBAT PROCESSES

| | | | Unit Level | Ref Page |
|---|---|---|---|---|
| 1. | **EEA: Maneuver** | | | |
| a. | MOE: | Force ratio - beginning | | |
| | MOP: | Did the unit receive AT fire? | C P | A-2 |
| | | Did the unit react to AT fire? | C P | A-2 |
| | | Did the unit react to small arms fire? | C P | A-2 |
| | | Did the unit receive small arms fire? | C P | A-2 |
| b. | MOE: | Force ratio - end | | |
| | MOP: | Was organic fire support used? | B C P | A-3 |
| | | Was external fire support used? | B C P | A-3 |
| | | What proportion of available weapons employed? | B C P | A-3 |
| c. | MOE: | Number of hits per number of firings by major weapons system (mws) | | |
| | MOP: | Was a priority of targets specified? | B C P | A-5 |
| | | What was the time exposed until engaged? | C P | A-5 |
| | | What was the time engaged until hit? | C P | A-5 |
| | | How many times was additional equipment required by type? | B | A-5 |

| | | | Unit Level | Ref Page |
|---|---|---|---|---|
| d. | MOE: | Actual detection (time-distance) | | |
| | MOP: | How much time was required to detect OPFOR? | B C P | A-7 |
| | | How much time is required to return direct fire? | C P | A-8 |
| | | Did the unit respond immediately upon enemy contact? | C P | A-8 |
| | | How many times OPFOR detected vehicles? | C P | A-8 |
| | | Did the OPFOR detect vehicles? | B C P | A-9 |
| | | What was the distance of friendly force to enemy force? | B C P | A-9 |
| | | Were air attacks detected? | B | A-9 |
| e. | MOE: | Percentage of enemy losses inflicted (direct fire) by mws | | |
| | MOP: | Was fire concentrated primarily on high-threat targets? | B C P | A-10 |
| | | Was an effective rate of fire maintained? | C P | A-10 |
| | | Were tanks, ATGM's employed in depth? | B C | A-11 |
| | | Did the same weapon hit the same target more than once? | B C P | A-11 |

| | | | Unit Level | Ref Page |
|---|---|---|---|---|
| f. | MOE: | Percentage of enemy losses inflicted by (direct fire) maneuver and unit | | |
| | MOP: | Did the unit counter-attack? | B C P | A-13 |
| | | Were hostile aircraft engaged? | C P | A-13 |
| | | Did unit maneuver in response to contact? | B C P | A-13 |
| g. | MOE: | Planned vs actual (distance-time) engagement | | |
| | MOP: | How long did it take to move from one position to another? | CcP | A-15 |
| h. | MOE: | Number of OPFOR destroyed (function of range)<br>MOP: none | | |
| i. | MOE: | Planned vs actual:<br>a) unit maneuver (include CPs, trains)<br>b) disengagement | | |
| | MOP: | How many times was FPF used to vacate sector? | C P | A-16 |
| | | Was dispersion maintained? | B C P | A-20 |
| | | How many units were engaged in maneuver? | C P | A-22 |
| | | How many units were engaged in overwatch? | C P | A-22 |

| | | | Unit Level | Ref Page |
|---|---|---|---|---|
| j. | MOE: | Firing time (by mws) from ID to engage | | |
| | MOP: | How long did it take to engage OPFOR personnel while moving? | B C P | A-25 |
| | | How long did it take to engage OPFOR personnel while stationary? | B C P | A-25 |
| | | How long did it take to engage OPFOR vehicles while moving? | C P | A-25 |
| | | How long did it take to engage OPFOR vehicles while stationary? | C P | A-25 |
| | | Did fire support the attack during the assault? | B C P | A-25 |
| | | Are the OPFOR engaged at the maximum effective range? | B C P | A-25 |
| k. | MOE: | Rate of Blue movement<br>MOP: none | | |

3. EEA: Fire Support

| | | | Unit Level | Ref Page |
|---|---|---|---|---|
| a. | MOE: | Response time for indirect fire requirements (call for fire to fire for effect)<br>MOP: none | | |
| b. | MOE: | Number of sorties allocated vs sorties utilized<br>MOP: none | | |
| c. | MOE: | Number of sorties flown vs aircraft lost | | |
| | MOP: | Was effect of weather on close air support assessed? | B | A-32 |

| | | | Unit Level | Ref Page |
|---|---|---|---|---|
| d. | MOE: | Number of OPFOR assets lost by weapons system (T-64, BMP, people, etc) to close air support | | |
| | MOP: | Were controlled fires employed to suppress or destroy enemy? | B | A-33 |
| | | Were hostile aircraft engaged? | B | A-33 |
| | | Were surface targets engaged? | B C P | A-33 |
| | | Were OPFOR targets attacked? | B C | A-34 |
| | | How long did btry maintain firing capability? | B C | A-33 |
| e. | MOE: | Range at which OPFOR deployed | | |
| | MOP: | Are the OPFOR engaged at the maximum effective range? | | A-36 |
| f. | MOE: | Percent of Fire Missions fired | | |
| | MOP: | Are weapons fired? | B C | A-38 |
| g. | MOE: | Response time for indirect fire requirements | | |
| | MOP: | Did the weapons function? | B C P | A-40 |
| h. | MOE: | Number of suppression missions fired vs number of weapons systems suppressed<br>MOP: none | | |

| | | Unit Level | Ref Page |
|---|---|---|---|
| 3. | EEA: Mobility/Counter-mobility | | |
| a. | MOE: Time for OPFOR to break obstacles<br>MOP: none | | |
| b. | MOE: Number of OPFOR losses during breach<br>MOP: none | | |
| c. | MOE: Time to breach obstacles (for US)<br>MOP: none | | |
| d. | MOE: Number of Blue losses during breach<br>MOP: none | | |
| e. | MOE: Number (percent) of obstacles encountered by OPFOR<br>MOP: none | | |
| f. | MOE: Rate of OPFOR movement | | |
| | MOP: Were fires shifted to OPFOR withdrawal routes? | B C P | A-49 |
| g. | MOE: Number/percent of engineer assets lost<br>MOP: none | | |
| h. | MOE: Number planned vs. emplaced/completed engineer rasks<br>MOP: none | | |
| i. | MOE: Percent of engineer/ equipment hours utilized per number of availability<br>MOP: none | | |
| j. | MOE: Percentage of hit vs engagement as a function of: weapon, exposure, degree of exposure<br>MOP: none | | |

| | | | Unit Level | Ref Page |
|---|---|---|---|---|
| 4. | EEA: Air Defense | | | |
| a. | MOE: | Number of hostile aircraft that attacked Blue forces<br>MOP: none | | |
| b. | MOE: | Number of casualties due to enemy air | | |
| | MOP: | How often was ADA unit maneuvering? | B | A-59 |
| | | How many times were two or more surveillance or target acquisition devices employed? | B | A-59 |
| | | How many times was radar scan rotation direction and speed changed? | B | A-59 |
| | | Were weapons fired at attacking aircraft? | B | A-60 |
| c. | MOE: | Percent killed by weapons system | | |
| | MOP: | How many REDEYE fired at each aircraft? | B | A-61 |
| d. | MOE: | Percentage of hostiles engaged that were killed | | |
| | | How many weapons fired at attacking aircraft? | B | A-62 |
| e. | MOE: | Percentage of engageables that were engaged per weapons system | | |
| | | Was one section (two Vulcans) positioned behind the lead company? | B | A-63 |
| | | Was one section (two Vulcans) positioned to the rear of the last company? | B | A-63 |

| | | | Unit Level | Ref Page |
|---|---|---|---|---|
| | | How many REDEYES were employed when the target was within range? | B | A-63 |
| | | Did ADA unit respond to enemy air activity? | B | A-63 |
| f. | MOE: | Percentage of attackers who were engageable | | |
| | | Were surface targets engaged? | B | A-65 |

5. EEA: Combat Service Support

a. MOE: Number of MWS out of action for maintenance/ number of MWS assigned
MOP: none.

b. MOE: Number of other major systems out of action for maintenance/number of such systems assigned
MOP: none

c. MOE: Time to repair returned systems
MOP: none

d. MOE: Number of major weapons systems out of action/ number of major systems returned to action
MOP: none

e. MOE: Number of other major systems out of action/ number of other systems reutrned to action
MOP: none

f. MOE: Number of major systems where maintenance was resolved
MOP: none

Unit Level | Ref Page

g. MOE: Number of organizationally repairable equipment Subset: out of action for maintenance/number of pieces of such equipment assigned
MOP: none

h. MOE: Maintenance support request/answered
MOP: none

i. MOE: Number of major weapons systems over time out of action due to lack of supply of:
MOP: none

j. MOE: Effectiveness of CSS in fields other than maintenance and supply
MOP: none

6. EEA: NBC

a. MOE: Number of casualties from NBC vs number exposed
MOP: none

b. MOE: Manhours/equipment directed from primary mission
MOP: none

c. MOE: Manhours/equipment diverted from primary mission

a) initial

b) residual

MOP: none

7. EEA: Command and Control, Communications

a. MOE: Number of messages attempted vs number of transmissions acknowledged

| | | | Unit Level | Ref Page |
|---|---|---|---|---|
| | MOP: | How long did it take to adjust illumination? | B C P | A-84 |
| | | How many times were indirect fires called to suppress vacated sector? | B C P | A-85 |
| | | Were support fires adjusted according to situation as required? | B C P | A-85 |
| | | Were support fires shifted or lifted as required? | B C P | A-85 |
| b. | MOE: | Lapsed time of transmission (decision time from receipt of info until passed on)<br>MOP: none | | |
| c. | MOE: | Time from information in to action out<br>MOP: none | | |
| d. | MOE: | Number of EEFI exposed to OPFOR compromised<br>a) ELINT<br>b) COMSEC<br>c) SIGSEC<br>d) Counter Surveillance<br>e) Etc.<br>MOP: none | | |
| e. | MOE: | Total top to action and/or bottom to action time | | |
| | | How many of weapon/systems were able to cover OP's/LP's? | B C | A-132 |
| f. | MOE: | Time from immediate request to execution<br>MOP: none | | |

| | | | Unit Level | Ref Page |
|---|---|---|---|---|
| 8. | <u>EEA: Intelligence/Counter Intelligence</u> | | | |
| a. | MOE: | EEFI compromised | | |
| | MOP: | How many of supporting fires were covering OP's? LP's? | B C | A-132 |
| | | What was the distance from each fighting position each weapon/ weapon system could observe and fire? | B C | A-136 |
| | | Did vehicle positioning permit rapid displacement? | C P | A-139 |
| | | Was battery able to conduct emergency fire mission (hipshoot)? | C P | A-139 |
| | | How many TF elements were in overwatch while maneuver units were exposed? | B | A-144 |
| | | Was the type of mission or characteristics of MIJI determined? | B C | A-146 |
| | | How many radios relocated to avoid detections? | B C | A-152 |
| b. | MOE: | Number of OPFOR detectable/number of OPFOR detected (by time and location). (Detected includes reported) | | |
| | MOP: | Was reported enemy location the actual enemy location? | B C P | A-157 |
| c. | MOE: | Number of total OPFOR accurately described in terms of location, composition, and intention/ number of total OPFOR | | |

| | | Unit Level | Ref Page |
|---|---|---|---|
| MOP: | Were fires shifted to OPFOR withdrawal routes? | B C P | A-162 |

C. COMBAT OUTCOMES

1. EEA: Maneuver

| | | | Unit Level | Ref Page |
|---|---|---|---|---|
| a. | MOE: | Force ratio - beginning | | |
| | MOP: | How much time was required to initiate maneuver? | B C | A-2 |
| | | How long did it take the unit to react to small arms fire? | C P | A-2 |
| | | What percent of pieces engaged in initial contact? | B C P | A-2 |
| b. | MOE: | Force ratio - end | | |
| | MOP: | How many casualties were taken? | B C P | A-3 |
| | | How many casualties per air attack? | B | A-3 |
| | | How many total casualties were assessed? | B C P | A-3 |
| | | How many targets were suppressed? | B C P | A-3 |
| | | How much (by type) of equipment was affected? | B | A-4 |
| | | How many friendly vehicles were damaged? | B C P | A-4 |
| c. | MOE: | Number of hits per number of firings by major weapons system (mws) | | |
| | MOP: | How many enemy targets are attacked? | B C P | A-5 |

| | | | Unit Level | Ref Page |
|---|---|---|---|---|
| | | How many targets were suppressed by indirect fire? | C P | A-5 |
| | | How long was each vehicle exposed? | C P | A-5 |
| d. | MOE: | Actual detection (time-distance) | | |
| | MOP: | Were OPFOR positions located? | B C P | A-7 |
| | | How many times were OPFOR positions located? | B C P | A-7 |
| | | Did the unit detect the OPFOR? | B C P | A-7 |
| | | Was reported enemy location the actual location? | B C P | A-7 |
| | | What was the TF reaction time to maneuver and counter an OPFOR obstacle upon initial contact by lead elements? | B | A-7 |
| | | How many OPFOR were detected? | B C P | A-8 |
| | | How much time was required to reach cover? | C P | A-8 |
| | | What was the number of true detections? | C P | A-9 |
| | | What was the friendly/enemy detection ratio? | B C P | A-9 |
| | | How many times was the OPFOR located? (By unit)? | B C P | A-9 |
| | | How many targets were detected? | B C P | A-9 |
| | | What was the percent of friendly detections by enemy air? | B | A-9 |

| | | Unit Level | Ref Page |
|---|---|---|---|
| e. MOE: | Percentage of enemy losses inflicted (direct fire) by mws | | |
| MOP: | How many targets destroyed by suppressive indirect fire? | C P | A-6 |
| | What was the range of the first engagement? | B C P | A-6 |
| | How many targets were suppressed by direct fire? | B C P | A-10 |
| | How many targets were destroyed by direct fire? | C P | A-10 |
| | How many rounds to destroy targets by type of weapon? | B C | A-10 |
| | How many rounds to hit targets by type of weapon? | B C | A-10 |
| | How many rounds to suppress target by type of weapon? | B C | A-10 |
| | How many high-threat targets destroyed? | C P | A-11 |
| | How many hits occurred per target? | C P | A-11 |
| | How many times were requested fires not beyond range of direct fire weapons? | C P | A-11 |
| | How many hits per target? | B C P | A-12 |
| | What was the loss rate equipment? | B C | A-12 |

| | | | Unit Level | Ref Page |
|---|---|---|---|---|
| f. | MOE: | Percentage of enemy losses inflicted by (direct fire) maneuver and unit | | |
| | MOP: | What number of target hits were achieved by each weapon, by type? | C P | A-13 |
| | | How many targets hit by direct fire weapons? | C P | A-13 |
| | | How many OPFOR vehicle casualties were there? | C P | A-13 |
| | | How many OPFOR were suppressed? | B C | A-13 |
| | | How many rounds are required to suppress the OPFOR? | B C | A-13 |
| | | How many rounds are required to destroy the OPFOR? | B C P | A-13 |
| | | How many rounds are fired per weapon? | C P | A-13 |
| | | Did the unit destroy OPFOR? | B C P | A-13 |
| g. | MOE: | Planned vs actual (distance-time) engagement | | |
| | MOP: | How many weapons functioned? | C P | A-15 |
| | | How many high threat targets were destroyed? | B C | A-15 |
| | | What was the average number of rounds fired from each position before moving? | C P | A-15 |

| | | | Unit Level | Ref Page |
|---|---|---|---|---|
| h. | MOE: | Number of OPFOR destroyed (function of range) | | |
| | MOP: | What is the average range of first detections? | B C | A-17 |
| | | What was the OPFOR movement rate? | B C | A-17 |
| | | How much time is required to suppress the OPFOR? | B C P | A-17 |
| | | How much time is required to destroy the OPFOR? | B C P | A-18 |
| | | How many enemy targets are destroyed? | B C P | A-18 |
| | | Were OPFOR targets destroyed? | C P | A-18 |
| | | How many targets are hit by type of weapon? | B C P | A-18 |
| | | How many targets are killed by type of weapon? | B C P | A-18 |
| i. | MOE: | Planned vs actual:<br>a) unit maneuver (include CPs, trains)<br>b) disengagement | | |
| | MOP: | How many targets engaged (or killed) by more than one weapon system? | C P | A-16 |
| | | What percent engagement within the effective range of weapons systems? | B C P | A-16 |

| | | | Unit Level | Ref Page |
|---|---|---|---|---|
| | | How long did each movement take? | B | A-19 |
| | | How many OPFOR were destroyed while vacating sector? | B C P | A-20 |
| | | How many friendly elements were destroyed when vacating sector? | B C | A-20 |
| | | How many elements did not relocate to designated locations? | B C P | A-21 |
| | | At what range did disengagement occur? | C P | A-22 |
| | | How much time is required to relocate a unit? | B C P | A-22 |
| | | What percent of time did the unit use travelling overwatch? | B C P | A-23 |
| j. | MOE: | Firing time (by mws) from ID to engage | | |
| | MOP: | How long was the unit engaged until hit? | B C P | A-25 |
| | | How long was the target engaged until hit? | B C P | A-25 |
| k. | MOE: | Rate of Blue movement MOP: none | | |

2. <u>EEA: Fire Support</u>

| | | | | |
|---|---|---|---|---|
| a. | MOE: | Response time for indirect fire requirements (call for fire to fire for effect) | | |
| | MOP: | Did indirect fire unit stay within CSR? | B | A-29 |

| | | | Unit Level | Ref Page |
|---|---|---|---|---|
| b. | MOE: | Number of sorties allocated vs sorties utilized<br>MOP: none | | |
| c. | MOE: | Number of sorties flown vs aircraft lost<br>MOP: none | | |
| d. | MOE: | Number of OPFOR assets lost by weapons system (T-64, BMP, people, etc.) to close air support (Subset: percent of total battle casualties by CAS) | | |
| | MOP: | How many targets engaged were outside unit sector? | B | A-33 |
| | | How many weapons employed on high-threat targets? | B C | A-33 |
| | | How many high-threat targets detected? | B C | A-33 |
| | | How many high-threat targets engaged? | B C | A-33 |
| | | How many detected targets are attacked? | B C | A-33 |
| | | How much of the basic load was expended? | B C P | A-33 |
| | | How many rounds hit the target (by weapons)? | B C P | A-33 |
| | | How many friendly targets are destroyed? | B | A-33 |
| | | What were the no. of times that ADA direct suppressive fire was used? | B | A-33 |

| | | | Unit Level | Ref Page |
|---|---|---|---|---|
| | | How many rounds impacted in target area? | B | A-33 |
| | | Were there friendly fire incidents? | B C P | A-33 |
| e. | MOE: | Range at which OPFOR deployed | | |
| | MOP: | How many high threat targets were destroyed? | B C | A-35 |
| | | How many OPFOR were destroyed while vacating sector? | B C P | A-35 |
| | | How many times were smoke missions fired? | B | A-36 |
| | | How many times were requested fires not beyond range of direct fire weapons? | B C | A-36 |
| | | How many rounds impacted in target area? | B C P | A-36 |
| | | How much time is required to suppress the OPFOR? | B | A-36 |
| | | How many rounds are required to suppress the OPFOR? | B | A-36 |
| | | How many of the available targets are attacked? | B C P | A-36 |
| | | How many fires were outside of sector? | B | A-36 |
| f. | MOE: | Percent of Fire Missions fired | | |
| | MOP: | How many indirect fire missions used smoke? | B | A-37 |

| | | Unit Level | Ref Page |
|---|---|---|---|
| | How many smoke missions were requested? | B | A-38 |
| | What was the immediate smoke-mean time (call for fire to target screened)? | B | A-38 |
| | How many total rounds were expended? | B | A-38 |
| | How many rounds are fired per weapon? | B C | A-38 |
| | How many indirect fire missions used smoke to support movements? | B C | A-38 |
| | How many FA missions fired? | B C | A-39 |
| | Were casulaties assessed on targets of opportunity? | B C | A-38 |
| g. MOE: | Response time for indirect fire requirements | | |
| MOP: | How many times was radar moved during a mission? | B | A-40 |
| h. MOE: | Number of suppression missions fired vs number of weapons systems suppressed | | |
| MOP: | How many targets are hit by type of weapon? | C P | A-41 |
| | What number of target hits were achieved by each weapon, by type? | C P | A-41 |
| | How many targets were suppressed by indirect fire? | B C | A-41 |

| | | Unit Level | Ref Page |
|---|---|---|---|
| | How many targets destroyed by suppressive indirect fire? | B C | A-41 |
| | What was the mean time to suppress targets? | B | A-42 |
| | How many targets were suppressed? | B C | A-42 |

3. <u>EEA: Mobility/Counter-mobility</u>

| | | | Unit Level | Ref Page |
|---|---|---|---|---|
| a. | MOE: | Time for OPFOR to break obstcles<br>MOP: none | | |
| b. | MOE: | Number of OPFOR losses during breach<br>MOP: none | | |
| c. | MOE: | Time to breach obstacles (for US)<br>MOP: none | | |
| d. | MOE: | Number of Blue losses during breach | | |
| | MOP: | How long was required to breach each obstacle? | B | A-47 |
| e. | MOE: | Number (percent) of obstacles encountered by OPFOR<br>MOP: none | | |
| f. | MOE: | Rate of OPFOR movement | | |
| | MOP: | Was OPFOR slowed? | B C | A-49 |
| | | How often was OPFOR canalized? | B | A-49 |
| g. | MOE: | Number/percent of engineer assets lost | | |
| | MOP: | How many total casualties were assessed? | B C P | A-51 |

| | | | Unit Level | Ref Page |
|---|---|---|---|---|
| | | How many casualties were assessed during an obstacle breach? | B C P | A-51 |
| h. | MOE: | Number planned vs emplaced/completed engineer task | | |
| | MOP: | How long does the obstacle stop the OPFOR? | B | A-52 |
| i. | MOE: | Percent of engineer/ equipment hours utilized per number of availa- bility<br>MOP: none | | |
| j. | MOE: | Percentage of hit vs engagement as a function of: weapon, exposure, degree of exposure | | |
| | MOP: | How many casualties were taken? | B C P | A-56 |
| | | How long was the unit engaged until hit? | C P | A-56 |
| | | How long was the target engaged until hit? | C P | A-56 |

4. EEA: Air Defense

| | | | Unit Level | Ref Page |
|---|---|---|---|---|
| a. | MOE: | Number of hostile air- craft that attacked Blue forces | | |
| | MOP: | How many air attacks were not detected? | B | A-57 |
| | | What percent of the vehicles were engaged by OPFOR aircraft? | B | A-57 |
| | | How many friendly tar- gets are destroyed? | B | A-57 |
| | | How many casualties were taken? | B | A-57 |

| | | | Unit Level | Ref Page |
|---|---|---|---|---|
| b. | MOE: | Number of casualties due to enemy air | | |
| | MOP: | How many times was radar moved during a mission? | B | A-59 |
| | | What was the casualty rate per air attack? | B | A-59 |
| | | How many casualties per air attack? | B | A-60 |
| | | How many of the vehicles were engaged by enemy aircraft? | B | A-60 |
| | | How many friendly aircraft were damaged/destroyed? | B | A-60 |
| | | How many US aircraft were engaged by attached Vulcan? | B | A-60 |
| | | Were transmitters DFed by OPFOR? | B | A-60 |
| | | How much time was required to detect OPFOR? | B | A-60 |
| c. | MOE: | Percent killed by weapons system | | |
| | MOP: | How many Redeye were expended? | B | A-61 |
| | | How many OPFOR aircraft were damaged/destroyed? | B | A-61 |
| | | How much of the basic load was expended? | B | A-61 |
| | | How many major items of ADA equipment were operational? | B | A-61 |

| | | | Unit Level | Ref Page |
|---|---|---|---|---|
| | | How many Vulcans fired at each aircraft? | B | A-61 |
| | | How many weapons/weapon systems were available? | B | A-61 |
| | | How much Vulcan ammunition was expended? | B | A-61 |
| | | How many rounds hit the target (by weapon)? | B | A-61 |
| | | How many targets are hit by type of weapon? | B | A-61 |
| | | How many targets are killed by type of weapon? | B | A-61 |
| | | How many rounds to destroy targets by type of weapon? | B | A-61 |
| | | How many rounds to hit targets by type of weapon? | B | A-61 |
| d. | MOE: | Percentage of hostiles engaged that were killed | | |
| | MOP: | How many air targets were engaged? | B | A-62 |
| | | How many OPFOR aircraft were damaged/destroyed? | B | A-62 |
| | | How many OPFOR aircraft were engaged by attached Vulcan? | B | A-62 |
| | | How many hits occurred per target? | B | A-62 |
| | | What number of targets hits were achieved by each weapon, by type? | B | A-62 |
| | | How many total rounds were expended? | B | A-62 |

| | | | Unit Level | Ref Page |
|---|---|---|---|---|
| e. | MOE: | Percentage of engageables that were engaged per weapons system | | |
| | MOP: | Were friendly aircraft engaged by Redeye? | B | A-63 |
| | | What percent of OPFOR aircraft were engaged by Vulcan? | B | A-63 |
| | | How many Redeyes were expended? | B | A-63 |
| | | Did the weapons function? | B | A-63 |
| | | What percent engagement within the effective range of weapons systems? | B | A-63 |
| | | Were OPFOR aircraft attacked by Redeye? | B | A-64 |
| | | How many Vulcans fired at each aircraft? | B | A-64 |
| | | How many Redeyes were fired? | B | A-64 |
| | | How many targets engaged (or killed) by more than one weapon system? | B C | A-64 |
| | | How many weaons functioned? | B C P | A-64 |
| f. | MOE: | Percentage of attackers who were engageable | | |
| | MOP: | How many fires were outside of section? | B C | A-65 |

5. <u>EEA: Combat Service Support</u>

a. MOE: Number of MWS out of action for maintenance/number of MWS assigned
MOP: none

| | | | Unit Level | Ref Page |
|---|---|---|---|---|
| b. | MOE: | Number of other major systems out of action for maintenance/number of such systems assigned | | |
| | MOP: | What percent of friendly vehicles were damaged? | B C | A-67 |
| | | What was the loss rate equipment? | B C P | A-67 |
| c. | MOE: | Time to repair returned systems<br>MOP: none | | |
| d. | MOE: | Number of major weapons systems out of action/ number of major systems returned to action | | |
| | MOP: | Were vehicles inopera-tive? (mobility) | B C | A-69 |
| | | What percent of units vehicles were recovered? | B | A-69 |
| | | How much (by type) of equipment was affected? | B | A-69 |
| e. | MOE: | Number of other major systems out of action/ number of other systems returned to action<br>MOP: none | | |
| f. | MOE: | Number of major systems where maintenance was resolved<br>MOP: none | | |
| g. | MOE: | Number of organization-ally repairable equipment Subset: out of action for maintenance/number of pieces of such equipment assigned | | |

| | | | Unit Level | Ref Page |
|---|---|---|---|---|
| | MOP: | How many vehicles malfunction? | B | A-72 |
| | | How many radios malfunction by type? | B | A-72 |
| h. | MOE: | Maintenance support request/answered | | |
| | MOP: | How many times was additional equipment required by type? | B | A-73 |
| | | What was the rate of equipment evacuation? | B | A-73 |
| i. | MOE: | Number of major weapons systems over time out of action due to lack of supply of: | | |
| | MOP: | Did TF stay within fire support expenditure restriction? | B C P | A-74 |
| j. | MOE: | Effectiveness of CSS in fields other than maintenance and supply<br>MOP: none | | |

6. EEA: NBC

| | | | Unit Level | Ref Page |
|---|---|---|---|---|
| a. | MOE: | Number of casualties from NBC vs number exposed | | |
| | MOP: | How long did it take to get mission essential equipment functioning after an OPFOR NBC strike? | B | A-80 |
| b. | MOE: | Manhours/equipment directed from primary mission<br>MOP: none | | |

| | | | Unit Level | Ref Page |
|---|---|---|---|---|
| c. | MOE: | Manhours/equipment diverted from primary mission<br>a) initial<br>b) residual | | |
| | MOP: | How long did it take to decontaminate Personnel? | B | A-81 |
| | | How long did it take to decontaminate equipment? | B | A-81 |

7. <u>EEA: Command and Control, Communications</u>

| | | | Unit Level | Ref Page |
|---|---|---|---|---|
| a. | MOE: | Number of messages attempted vs number of transmissions acknowledged | | |
| | MOP: | How long did illumination requests take to be fired? | B C P | A-84 |
| b. | MOE: | Lapsed time of transmission (decision time from receipt of info until passed on) | | |
| | MOP: | What was the TF reaction time to maneuver and counter OPFOR obstacle upon initial contact by lead elements? | B C | A-88 |
| | | How much time elapsed between warning order and movement? | B C P | A-88 |
| c. | MOE: | Time from information in to action out | | |
| | MOP: | What was the average distance between units? | B C P | A-93 |

| | | | Unit Level | Ref Page |
|---|---|---|---|---|
| d. | MOE: | Number of EEFI exposed to OPFOR compromised<br>a) ELINT<br>b) COMSEC<br>c) SIGSEC<br>d) Counter Surveillance<br>e) Etc. | | |
| | MOP: | What was the mean transmission time? | B C P | A-111 |
| | | How many transmitters were DFed by OPFOR? | B | A-111 |
| | | What percent of the time were scouts used to screen flanks? | B | A-113 |
| | | How long did it take messenger to get from point to point? | B | A-119 |
| | | How many times was radar moved during a mission? | B | A-122 |
| e. | MOE: | Total top to action and/ or bottom to action time | | |
| | MOP: | At what range did disengagement occur? | B C P | A-128 |
| f. | MOE: | Time from immediate request to execution | | |
| | MOP: | How long did a request for immediate suppression take from request to response? | B C P | A-124 |

8. <u>EEA: Intelligence/Counter Intelligence</u>

| | | | | |
|---|---|---|---|---|
| a. | MOE: | EEFI compromised | | |
| | MOP: | How many times was the radar site moved? | B | A-145 |

| | | Unit Level | Ref Page |
|---|---|---|---|
| | Was the OPFOR located? | B C | A-145 |
| | What equipment was affected by interference? | B C | A-146 |
| | When did MIJI begin? | B C | A-146 |
| | Did MIJI divert/disrupt the friendly force? | B | A-146 |
| | How much (by type) of equipment was effected? | B | A-147 |
| | How many incidents took place (meaconing, intrusion, jamming, interference)? | B | A-147 |
| | When did MIJI begin? | B | A-147 |
| | How many times was GSR detected by OPFOR DF equipment? | B | A-148 |
| | What was the number of true detections? | B C P | A-148 |
| | How many identifications were accurate? | B C P | A-149 |
| | How many nonmoving vehicles were detected by the OPFOR? | B C P | A-151 |
| b. MOE: | Number of OPFOR detectable/number of OPFOR detected (by time and location). (Detected includes reported.) | | |
| MOP: | What is the average range of first detection? | B C P | A-158 |

| | | | Unit Level | Ref Page |
|---|---|---|---|---|
| c. | MOE: | Number of total OPFOR accurately described in terms of location, composition, and intention/ number of total OPFOR | | |
| | MOP: | How many STANO devices were actually used at night? | B | A-160 |
| | | How many detections were valid of hostile aircraft? | B C | A-160 |
| | | How long did it take to detect hostile aircraft? | B C | A-160 |
| | | How many targets detected? | C P | A-162 |
| | | How many targets were detected by GSR? | B | A-164 |
| | | What was the range of detection of targets by GSR? | B | A-164 |

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